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CHEMICAL & METALLURGICAL ENGINEERING

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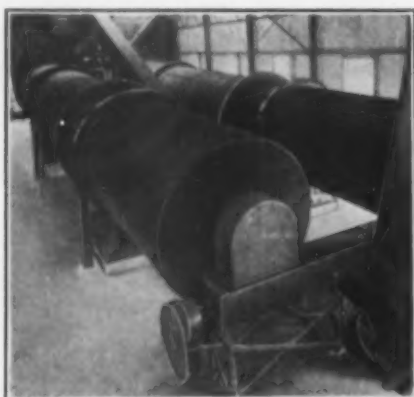
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Optimistic Outlook in The Chemical Industries

IN EXTENDING to the friends of CHEMICAL & METALLURGICAL ENGINEERING a cordial holiday greeting and sincere wish for a happy and prosperous New Year, the editors are not lightly repeating a perfunctory salutation. On the contrary, we are fully mindful of the serious industrial and economic problems which must be happily solved if our wish is to be consummated before Nineteen-Hundred and Twenty-One slips away. With the year that has gone we need have little concern except to profit by its lessons. In many respects it was disappointing. It had a skyrocket career; and while a skyrocket in flight is an interesting spectacle until after it bursts in radiant splendor at the zenith, there is always the dull and uninteresting but inevitable accompaniment—the descent of the stick.

But it is with neither the rise of the rocket nor the descent of the stick that we salute our friends. Rather do we wish to greet them at the opening of the year with a note of optimism and confidence which we ourselves feel and which we have found in a remarkable degree pervading the chemical industries. Being somewhat curious as to the mental attitude of manufacturers in the chemical and allied industries under the industrial depression which has prevailed for some time, and wishing to discover at first hand what plans they were making for the future, when they expected a revival of business and how they felt about our chemical industries as a whole, we resorted to the useful questionnaire. The replies have been gratifying. If we had been suffering from depressed spirits, we would have been revived by the expressions of optimism and confidence in the future voiced by our correspondents. Seventy-five per cent of them were distinctly optimistic, and the balance noncommittal. The current industrial depression has been felt by only 60 per cent, although some who have not yet felt it admit the possibility of a slight lull early this year. It is noteworthy, however, that two-thirds of our friends have neither reduced their forces nor curtailed their outputs. In many instances they are running on accumulated orders which will require from two to four months for completion, thus tiding them over any temporary lull in business which may occur between now and spring. Such labor as is being dispensed with is mainly the unskilled variety, because manufacturers of engineering and technical equipment and apparatus realize the value of the skilled artisan and are preserving their organizations. As a consequence we may conclude that unemployment is not widespread in these industries. In some cases forces are being reduced in order to weed out the inefficient, and the beneficent influence of this process has already been observed in the attitude of the employee toward his job.

Speculation has been rife as to the time when we might look for normal resumption of business. Economists, industrial leaders, business men and the average citizen have all made their guesses. The matter is not altogether one of psychology, because time is required for the physical accomplishment of certain things. Curiously enough, the impression seems to be almost universal that late spring or early summer should witness the transition from depression to activity. This opinion is concurred in by our correspondents.

As to the factors which will influence a speedy return to normal conditions, there is remarkable unanimity of opinion that tariff legislation is of primary and vital importance. There is a marked tendency to place confidence in the lawmakers at Washington, as well as to impose upon them the necessity for hard work and exercise of brain power. Not a few are of the opinion that Congress must listen more and more to technical advisers. The feeling that a tariff on dyes, chemicals and apparatus is essential arises largely from the fact that many of these industries have a direct relation to national welfare. In the case of dyes particularly, the fact that other nations have already protected their domestic industry only adds to the necessity of prompt action here.

Next to tariff protection, improvement in methods of taxation is mentioned as a factor in the return to normal business conditions. Next, in the opinion of our friends, is the matter of foreign exchange. Those who have commodities for export find it difficult, if not impossible, to do business at current rates, while those who are manufacturing in competition with foreign countries feel that the United States will become a dumping ground for cheap imports as long as the inequality in exchange exists. A hopeful note is sounded in one instance by a correspondent who sees the buying power of the dollar increased as domestic prices fall so that it will more nearly equal its value in foreign markets. It is noteworthy that few referred to the necessity of reducing wages as a prerequisite to business prosperity. Evidently manufacturers are not concerned so much with what a man earns as what return he gives for his wage.

Not infrequently during the past few years the fundamental soundness of our chemical industry has been the subject of question and discussion. Consequently we were particularly anxious to get the opinion of manufacturers on this point. The gist of the matter as contained in replies to our questionnaire is that in general the chemical and allied industries are on a sound basis, both financially and technically. This is particularly true with the organizations having large resources in men and money, though it is recognized that some of the smaller organizations which have been overcapitalized and poorly manned are not likely to weather the

distress of this period of readjustment. This curious but fatal combination prevails: Poor technology is observed in those organizations which have not the financial means to withstand the present strain. As a consequence they will fall under severe competitive conditions. If the service which they performed during the war is still needed it will be supplied by the larger organizations, whereas if their product is relatively unimportant, small in quantity and low in value, it may not be manufactured here at all. In any event it is the general impression that American chemical industry will hold most of the advanced positions gained during the war, although tariff protection is considered necessary in some instances.

All of this bears directly upon the ability with which we can meet foreign competition and establish ourselves in a position of independence. It is quite evident that industrial independence can usually be achieved if the people are willing to pay the price. Already there is evidence of the fact that competition with German and other European products is actively threatening the existence of some of the industries which during the war we came to regard as vitally necessary to our national welfare. As an example we may cite a widely used scientific instrument for which domestic manufacturers are charging about seven times as much as the cost of an imported article of equal grade. With such a discrepancy of price there is but one inevitable result, because buyers will look first at the price. The general feeling, however, as reflected in the replies to our questionnaire, is that the United States has thoroughly established its independence in those chemical industries which are characterized by large-scale production. On the contrary, it is not felt that the manufacture of many specialties has been perfected to a sufficiently high degree to meet foreign competition. Of course, a basic factor in the whole matter is the difference in cost of labor at home and abroad which cannot be materially altered by technology or good business methods.

Scattered here and there throughout our correspondence we find a few points mentioned only incidentally which we believe worthy of further emphasis. It is quite evident that those manufacturers who serve a diversity of consumers are in a strategic position when a period of depression comes. This can be accomplished in two ways: Either by manufacturing a variety of products for different industries or, more fortunately, producing some one thing that is useful in a number of industries. In either case the demand for the products may also have a seasonal nature which will distribute business uniformly throughout the year.

One of the most hopeful aspects of business in the chemical and allied industries is the money-saving and waste-eliminating character of the service, equipment or process offered by manufacturers and engineers. This is responsible for more than a few of our correspondents stating that inquiry for their product is more brisk than for some time past and that the prospect for closing contracts is unusually good. In other words, those who are prepared to put our industries on a scientific basis find their services in demand in direct proportion with the necessity for reducing costs, saving wastes, or increasing output.

Considering all conditions, we may conclude that what is now needful is business courage and respect for fundamental economic principles. Time will be required for the operation of economic laws, and some

distress will follow as a consequence; but if we look at business over a five-year instead of a one-year period, we may find current losses more than counterbalanced by earlier gains. Attempts to forestall by artificial means the inevitable readjustment now going on, or failure to understand the reason for it, or stubborn refusal to yield to it will only delay the revival of business. Psychologic as well as economic forces are at work. The latter are outside the scope of our influence, but to the former we want to add our note of courage, confidence and optimism, supported in tangible form by the judgment and testimony of leaders in the chemical and allied industries. By giving a little thought even a short period of adversity can be turned to useful purposes.

A Noteworthy Year In the Steel Market

THE steel trade is one that has a habit of breaking precedents and records. The changes occurring in the market have been likened to the view obtained in a kaleidoscope. It is not the changes that occurred in the steel market during 1920 that constitute the most noteworthy thing about the year, but the character of the market itself, with its flight of prices on the part of the independents and the even line maintained by the Steel Corporation. No steel manufacturer would have predicted what occurred, and none perhaps would have admitted the possibility of such a thing occurring. A few might have admitted the possibility, at the same time asserting that the actual event was so improbable as not to be worth considering.

It was at the end of 1919 that the independent steel makers as a whole were primed for a substantial advance in steel prices. Some had advanced their prices, but the appearance was that of charging premiums for early delivery and merely refraining from selling for later delivery at base prices. It was expected that the Steel Corporation would advance its prices, and when the corporation did not take the initiative it was thought that at any rate it would follow the independents on the up track. To many independents if not the majority the remarkable thing seemed to be, not that the independent market advanced, but that the Steel Corporation did not make advances.

It was not a case, however, of the independents abandoning an established philosophy, of holding prices steady. No similar conditions had obtained in the past. There was a new state of affairs in connection with which there were no precedents. It was the Industrial Board prices of March 21, 1919, to which the Steel Corporation adhered, and when those prices, representing the second reduction from the war control prices, were announced it was a common feeling among buyers of steel, and among not a few sellers, that the prices were on the whole too high. They were, as a matter of fact, shaded in the April and May following, and when eventually steel makers found that instead of its being necessary to let the whole market go down there was to be an opportunity to obtain higher prices for a time, it seemed natural enough to go while the going was good, or "make hay while the sun shines." There was a scarcity of steel, resulting from the iron and steel strike being followed closely by the bituminous coal strike, a temporary situation likely to be followed eventually by a collapse. There seemed to be no hope either of holding prices down at the time or of holding them up afterward.

One of the great difficulties of the situation was the lack of integration among some of the independents. Some steel producers must buy their pig iron, and many pig iron producers must buy their coke. The coke producer sought such profits as were obtainable, particularly when his coal had a very high market value, the amount of coal converted into merchant coke being scarcely more than the proverbial drop in the bucket when compared with the size of the coal trade as a whole. The merchant furnaceman sells more pig iron to foundries than to steel makers and could not be expected to hold down the price of steel-making pig iron. Some steel makers had to have high prices in order to meet their costs, and they could obtain the prices. Why should others not?

Profits were made, but production costs naturally rose, and a readjustment is already in progress. Costs cannot be reduced to the pre-war level, but various excrescences can be lopped off, and many have been already. Costs will now have to be regulated by selling prices, when formerly they were allowed to go where they would.

Making Plant Troubles Pay Dividends

THE Cottrell precipitator for recovery of fume forms the classic example of making profits from what were previously regarded as wastes or public nuisances. Many industries have used this means of dust or fume recovery to their financial advantage as well as for the improvement of their reputation among their neighbors. Fire and explosion prevention has generally been regarded as a necessary but costly problem with which the chemical plant must deal. However, new methods for elimination of fire and dust or vapor explosions give promise of being profitable, as well as effective for their primary purpose. This is possible through the use of inert gas methods for control of combustible vapors and dusts.

One large industrial plant which had numerous fires and a few small explosions caused by mixtures of air with the vapor of the solvent used is affording a striking example of the advantage of this work. This company installed equipment for making an inert gas mixture—carbon dioxide and nitrogen as the purified product of fuel combustion being the gas employed. This inert mixture carries off the vapor from the process, the solvent is absorbed from the gas by an oil-scrubbing process similar to that used for recovery of toluene from city gas, and the solvent is thus recovered. The result is safe and uninterrupted operation at very low cost and even this small cost is more than offset by the financial advantage through the solvent reclaimed. It is reported that this solvent costs about four cents a gallon instead of approximately thirty cents for new material.

There are many other industries using solvents under conditions that make explosion and fire hazard serious. The fire insurance interests have long since done their best to enforce care in these matters and have in many cases made it financially profitable to eliminate the principal hazard by largely increasing the insurance rates where the plant was not operated with maximum of safety. If one may add to this insurance saving the actual income from recovered solvents, there is certainly no longer an excuse for continuance of these dangerous plant practices.

Dyes, World Peace, And Chemical Disarmament

AFTER much controversy, during which it came dangerously near muddling the whole matter, the British Government has adopted a definite policy with relation to its dye industry. Parliament saved the industry at the eleventh hour by passing a regulatory bill, the text of which is printed elsewhere in this issue. In its principal features it prohibits, subject to a licensing system, the importation of synthetic organic dyes and intermediates used in their manufacture. The Board of Trade is constituted the licensing authority, supplemented by an advisory committee composed of manufacturers and consumers. The provisions of the bill are to apply for ten years and no longer, at the end of which time it is confidently expected that the British dye industry will be able to stand alone.

England's action holds a salutary lesson for the United States which the present Senate will do well to consider. Conditions in the two countries prior to England's recent action were almost identical. Neither nation had a well-developed, independent dye industry, both being large consumers of the German product. By the same token both nations were helpless in the early stages of gas warfare during the late conflict. Following the Armistice both nations regulated the importations of German dyes, and England announces her intention of supporting a domestic dye industry. Subsequently the famous Sankey judgment destroyed the government's authority to regulate dye imports, and as a consequence the industry was in a perilous position until the new dye bill was passed by Parliament late in December.

Our own position in respect to post-war regulation is still satisfactory, but should peace with Germany be declared prior to the passage of the Longworth dye bill by the Senate, the licensing authority of the War Trade Board Section of the State Department would be abrogated and the way would be open for unrestricted importation of German dyes. It is this critical situation which makes it incumbent upon this Senate to agree upon a measure which will protect the domestic dye industry and permit it to develop to a state of independence.

The necessity for protection of the dye industry until it can stand alone is not wholly an industrial and economic matter. Its relation to world peace is closer than is suspected at first glance. One of the steps advocated in the interest of world peace is international disarmament, but thus far the advocates of such a measure have considered physical disarmament only and have strangely neglected the greater necessity for chemical disarmament. The latter is practically impossible as long as any nation holds a world monopoly in the manufacture and distribution of synthetic coal-tar products. No thoughtful reader can peruse V. LEFEBURE's article, published on another page, without being forcibly struck with the author's logical reasoning on this subject. We commend it to the earnest consideration of our lawmakers and shall see to it that they have an opportunity to read it. It is immaterial whether LEFEBURE's complete scheme can be carried out at the present time, but it is of vital importance to recognize the fact that the United States, as well as the other leading nations of the earth, must have an independent dye industry, in the interest of chemical disarmament and world peace, if for no other reason.

Mechanical Training

For the Industrial Chemist

THE average chemist is essentially a theoretical man and without knowledge of mechanical matters, but he must acquire such information as will enable him to direct them to his purposes. The lack of the simplest knowledge of mechanics and construction details among chemists is deplorable. Instances may be cited.

A highly trained chemist, more through good fortune to himself than judgment on the part of his superiors, had secured an operating position with the responsibility, among other heavy charges, of starting the equipment in an enormous new manufacturing plant. He knew nothing about the simple need of sweating in a bearing and at first refused to run the machinery idle, preferring to wait until the material commenced to come through. He insisted that a simple turnover of a few minutes proved the readiness of the machines to handle the load. Finally, however, under the threat of dismissal from the staff chemical engineer, who had mechanical training, he was persuaded to start up without load. It developed during the three weeks' tune-up that none of the equipment was ready, that bearings burned out, shafts had to be re-aligned and in two instances entire change in design was necessary. Had these breakdowns occurred under load several months' delay would have been inevitable.

But one might say, "Call in the mechanical engineer." Unfortunately he is not always available. The mechanical engineer with a knowledge of chemical plants is, moreover, a *rara avis*. Two instances will illustrate.

A large number of steel containers designed to hold a poisonous gas under pressure were put in by mechanics. These had been pressure-tested at the factory but traveled a long distance in coming to the plant. The chemical engineer, much to the disgust of the mechanical engineer, insisted on a second test in place. He knew that leakage of the gas would suffocate the workmen in the whole plant and cause expensive shut-downs. Finally, he had his way, and on putting each under a 500-lb. hydraulic test—accomplished inexpensively with a hand pump—water spurted forth from the seams and even from the sides of the steel vessels. These leaks were soon stopped by oxy-acetylene torch and calking with a cold chisel. Many thousands of dollars and vexatious delays were saved. The risk to human life was reduced to nothing.

A Gay-Lussac acid tower stood on four brick piers erected with the footing in sand of an old river bed. Evidently two of them were located over decayed matter beneath the surface, for one day they suddenly sank several inches, tilting the structure to a dangerous angle. The manager called in a construction company to quote on straightening up the work. It returned an estimate of about \$2,000. In the meantime a practical chemical-engineer foreman asked for a chance to try before the construction company was retained and received permission from the manager.

He requisitioned two ordinary two-man timber saws from the storehouse and called in four workmen. They proceeded to saw out two courses of brickwork and mortar on each of the two high piers, working around the pier until at last a slim support of material was left in the center of each. Mortar was thrown into the spaces, the remaining material was chipped out and the tower settled back to the vertical, where it has since been standing for several years.

This chap knew that of all tools available to the industries there are very few for putting on material, most of them being "taking-off" tools, and he simply saw it was easier to saw off a leg than to put one on. This is not chemical engineering, but common sense, which carries men far in business, chemical engineers included.

Gossiping Tongues

Injure the Profession

SOME time ago we heard a veritable tale of woe in regard to a commercial laboratory in good standing. The "kicker" declared himself to have been robbed by it of large sums of money, and to have been involved in a great waste of time with no results and, as he believed, no genuine effort to show for it. The man was not a chemist, but he talked with fervor, and his bitterness aroused our curiosity inasmuch as we knew the consulting chemist against whom the complaint was directed to be scrupulously careful, very competent in science, rich in technological experience, and a man of honor. So we proceeded with a little investigation of our own, and found three chemical laboratories involved instead of one—a little fact that was not related by the complainant and which the three chemists themselves did not know. We shall designate them as A, B, and C respectively. It was B who was the butt of the manufacturer's diatribe on the occasion in question.

What happened was that A was retained to develop a process, which he did. He did not finish his work, having carried it only to the initial stage. Then Mr. Manufacturer went to B without telling him anything of A and consulted him in regard to the process of which he declared he had made an initial instalment. B took the matter up where A had left it, and designated the necessary steps to carry it to completion. For this B charged a fee of \$75 and \$6.32 traveling expenses. Considerable correspondence of a friendly nature ensued for which no charge was made, which related to what the manufacturer would do when he had his complete apparatus installed. Without purchasing the apparatus at all Mr. Manufacturer then went to C, and how C is coming along with him we do not know, but we can guess.

All three are competent men; any one of them could have developed the process and carried it through to profitable operation; but the pig-headed manufacturer cannot understand chemical consequences; he does not know the difference between work in glass and in iron, he takes his chemistry as a lot of yokels take patent medicines, and the only so-called "reason" to which he will listen must emanate from men as ignorant of chemistry as he.

What is needed is less destructive gossip and more co-operation among consulting chemists. There is no profit whatever in letting ignorant men engage in loose and libelous talk about the vain things which they imagine. A few libel suits would do no harm in this respect. When a man begins to libel a brother chemist it is a good thing to make him give facts and figures, and then to send this record in to the man against whom the complaint is made. We do not want to put anything in the way of men of affairs seeking advice and counsel where they desire to get it; but we should like to see a halt called to malicious gossip. There is too much of it going on that has no foundation in fact, and that has its origin in crass and sour ignorance. It injures the whole profession.

Chemical Disarmament

The Author Passes in Review the Chemical Armament Implied in Chemical Warfare and Shows That the Crux of All Chemical Disarmament Must Be an Internationally Legalized Redistribution of Organic Chemical Producing Capacity Throughout the World

By V. LEFEBURE

WHAT is the present disarmament situation? Chemical disarmament is the crux of all disarmament.

The League of Nations, representing most of the nationalities, with the notable exceptions of America, Germany and Russia, has instituted a definite commission to consider the question of world disarmament. Of the above exceptions acute interest must be attached to the American attitude. The initiative for any new disarmament schemes, an essential backing of any such schemes already before the world, must come from America with special weight. We may safely assume that in the block of nations represented by the League there is a desire for peace and any measures which can insure it. No doubt can exist that this feeling is common to America. On this common ground, therefore, all parties, whether associated with or hostile to the League, must welcome any new light on the critical disarmament situation.

A brief analysis of armament reveals the fact that disarmament must cover three essential factors in warfare—the combatants, mechanical types of armament and war chemicals. Mechanical armament covers all projectile-throwing weapons, or projectors as we will call them, tanks, aircraft, appliances for transportation, warships, etc.

CHEMICAL ARMAMENT

Chemical armament, very generally, represents the actual death-dealing constituents of projectiles. This must, however, be qualified by the statement that although all pre-war chemical armament—that is to say, explosives—required a special projectile to convey it to the enemy—that is to say, was dependent on a shell—the new type of chemical armament has become in some cases and may increasingly become independent of any special projectile. This is a most important item from the point of view of disarmament. It means that the limitation of projectiles may not carry with it limitation of the chemical weapon.

It is fairly safe to assume that any world organization devising disarmament schemes could cover with a fair degree of certainty the first two forms—that is, the combatant and the mechanical type of warfare. It can be claimed that the component parts of mechanical armament can be produced rapidly in easily-converted peace-time factories. This applies, for example, to machine-gun parts; but all of these weapons, if produced in quantity, necessitate huge assembly plants, and these without doubt can be subjected to inspection and control.

But how do normal disarmament schemes apply to

the chemical type? This type of weapon covers, roughly, two classes—explosives and the so-called poison gases. Now we must at once correct any false impression as to the relative importance of these two sections of chemical armament. The recent war has witnessed a gradual change in this matter. Explosives which at the commencement of the war represented nearly 100 per cent of all projectile fillings can no longer claim more than 50 per cent of that capacity. This can be substantiated in many ways. It is sufficient, however, to point to the fact that in the last great German retreat their huge ammunition dumps which we captured contained at least and in many cases more than 50 per cent of shell which were filled not with explosives but with the other type of war chemical, commonly called poison gas. There is no doubt that another year of war would have seen this percentage greatly increased.

CONVERTIBILITY OF DYE PLANTS FOR POISON GAS PRODUCTION

Pursuing our analysis, we must face the following question: Is there any essential difference in the disarmament aspect of explosives and the other types of war chemical? They have one common characteristic. This is their peace-time use. This refuses to any disarmament scheme the right to disarm in the simplest fashion—that is, by the total destruction of producing capacity. The world must have for normal development a large producing capacity for explosives and for the other types of chemical armament. This is self-evident for explosives, but may not be so for poison gas. We can readily establish the point, however, that the poison gas or chemical warfare campaign was initiated, fostered and most thoroughly exploited by Germany of all the belligerents. This country produced practically every ounce of her hundreds of thousands of tons of poison gas in dye plants, in dye factories. The examination of German gas production leaves no doubt whatever that the infinitely flexible, almost instantaneously converted dye plants are a logical means of production of all organic chemical weapons, including explosives.

FACTS TO BE CONSIDERED IN CONNECTION WITH CHEMICAL DISARMAMENT

We must now stop to lay emphasis on a general principle. There are two methods of disarmament. In the first class you can disarm very simply by destroying all the means of production and preventing their renewed growth. In the second class, because the means of production—the factories—have a peace-time function, you cannot disarm by destruction. How then can you disarm in this case?

There is only one way—it is to insure that no one country possesses a monopoly in the means of produc-

EDITOR'S NOTE—The author was British liaison officer with the French forces from the inception of chemical warfare until after the Peace Conference and is especially qualified to speak with authority on this subject.

tion. The brightest and most telling war chemical invention has no value for and no incidence upon warfare unless it can be produced rapidly and in quantity. Production is the key to its war use. Let us examine very briefly, therefore, the world distribution of the means of production for this new type of weapon. The facts are too well known to demand more than a brief reference. Before the war Germany held the almost absolute monopoly of world organic chemical production. Through this monopoly she launched the poison gas campaign, and for more than two years the Allied reply was relatively feeble. This was not due to Allied lack of invention, but to lack of producing capacity. Production occurred in improvised plants which weakened Allied resources and, most important of all, introduced no essential change in the German monopoly position.

During the war, however, for economic rather than military reasons, dye-producing industries sprang up in France, America and England. Their development was relatively feeble, owing to numerous obvious reasons. They could not make their just demand upon the research forces of the countries concerned. The erection of the plants suffered at the expense of the other great munitions industries which were developing, and in some cases as soon as a plant was erected the dire needs of the situation diverted its production from that of dyes to that of explosives and other organic chemicals. From the point of view of our argument this development left the world in the following situation regarding organic chemical producing capacity:

The German dye industry, the source of her war chemical production, was considerably strengthened. She had a world monopoly before the war, and in every way from the point of view of production, research forces, government support, etc., she was strengthened by the war in her bid for post-war world monopoly. Other countries than Germany were left with promising but relatively feeble organic chemical resources which could not immediately, even under normal commercial conditions, hope to break the German monopoly. In other words, although for most types of armament the pre-war balance in favor of Germany was decreased, yet for this one type of chemical armament the German monopoly was strengthened.

WHAT THE GERMAN ORGANIC CHEMICAL MONOPOLY IMPLIES

We are, therefore, left in face of the following situation: For most types of armament the war has led to a redistribution of producing capacity in the direction of an equilibrium. We can reasonably hope, by materially diminishing this capacity and suitably controlling and inspecting it, to obtain international disarmament; but in one particular, in chemical warfare, for which the means of production is organic chemical capacity, the final situation is just as remote from any equilibrium as it was before the war. Now we cannot, for the reasons already given, urge the complete destruction of the German producing capacity. On the other hand, disarmament in all other weapons will leave the war importance of chemical warfare greatly enhanced.

The conclusion is obvious. The world must have organic chemical producing capacity, but it cannot tolerate a monopoly of that capacity, especially if that monopoly be held by those who so drastically abused its possession. There must be a redistribution of organic chemical producing capacity throughout the world before we can claim to have even approached

disarmament. It would be farcical to proceed with general disarmament schemes and to leave untouched this monopoly in chemical armament. It can, therefore, be claimed without any exaggeration that the chief question before those who wish to see the world on a peace footing is the redistribution of this capacity throughout the world. In other words—and to ignore this issue is dangerous—we must break the German organic chemical monopoly.

How can this be achieved? There are two main avenues of approach. The new-born dye industries of France, America and England, and if you wish, other countries, must be supported nationally through legislation, and internationally through some such organization as the League of Nations; or, for those who oppose the latter, support must come on the common grounds of disarmament toward stable world peace.

INTERNATIONAL MEASURES NEEDED TO REGULATE CHEMICAL DISARMAMENT

In America and England legislation designed to protect the dye industry is before both countries. The issue is likely to be fought out on purely national grounds. This alone is entirely unsatisfactory. It must be realized by all concerned that they are legislating on a matter which has infinitely more than commercial significance. They are legislating on world peace. If that be so, they deserve the active support of those whose chief business is the promotion of this peace by definite international measures. From this point of view it is imperative that in France and England the League of Nations representatives should bring the matter strongly to the notice of the League of Nations, where it should be dealt with by their special Disarmament Commission. America can be a strong factor in this connection. A recent request has been made by the League for the appointment of an American representative to attend the disarmament conferences at Geneva. Although America is not a member of the League, and even if she be hostile to it, this representative will have great weight in these conferences.

Chemical disarmament is a matter which, unfortunately, non-technical people do not fully understand. They think it sufficient to issue an edict against the use of poison gas, not realizing that this alone is absolutely futile as an effective measure. You cannot prevent any discoveries in chemical warfare, because, unlike the development of mechanical invention, such chemical discoveries can occur, when directed by a trained mind, with the mere use of a few pots, pans, beakers, in any unguarded and unsuspected locality. The redistribution of producing capacity is therefore critical. It is, therefore, very important from the point of view of disarmament that any American representative proceeding to Geneva should have a clear view of the fundamental principles of chemical disarmament and make strong representations on this matter.

A LEAGUE OF NATIONS OUGHT TO STUDY THE REDISTRIBUTION OF THE WORLD DYE INDUSTRY

The present League or any league cannot fairly demand and expect a satisfactory answer to its request that governments should cease to support chemical warfare research and chemical military establishments unless that league be ready to support in its turn the essential chemical disarmament measure—that is, the redistribution of the world dye industry and the break-

ing of the German monopoly. From another point of view, essential action has been neglected on this matter and should be taken up again by the League of Nations, by those making representations to it or having any weight with it, by those responsible for the execution of the Treaty of Versailles and by America in any new treaty which she may make with Germany.

Articles 168 and 169 of the Treaty of Versailles are specially concerned. The former provides for the restriction by the Allied and Associated Powers of the manufacture of war material and of the approval of those Powers for the continued existence of factories and works for such production in Germany. On these grounds it is logically possible to limit seriously that capacity of the German dye industry which produced poison gases during the war and may continue to do so. Article 169 provides for the surrender to the Allied and Associated Powers of any special plant intended for the manufacture of military material, except such as may be recognized as necessary for equipping the authorized

strength of the German army. The execution of this clause, if a proper interpretation of chemical armament be used, would imply the closing down of many of the German dye plants which produced those huge quantities of poison gases during the war.

We repeat that the crux of all disarmament is the redistribution of organic chemical capacity throughout the world, and that, interpreted into action, this implies the serious reduction of the producing capacity of the German dye monopoly and the international support by the League of Nations, or any other similar bodies which may be established, of the legislative measures about to be brought before such countries as America and England for the protection of the growing dye industries, replacing the reduced German dye-producing capacity in those two countries. This is, without any doubt, one of the most important measures now before the world and in addition one of the few measures with regard to which immediate action can be taken toward the stabilization of world peace.

Election of Officers and Directors of the Allied Chemical & Dye Corporation and Subsidiaries

Personnel of the Allied Board—New Interlocking Directorate Elected by Barrett and National Aniline Companies—Changes to Make Boards of Active Executives

AT THE organization meeting of the Allied Chemical & Dye Corporation, Dec. 21, the following directors were elected:

Chairman of Board, Dr. W. H. Nichols of General Chemical
President, O. F. Weber, National Aniline

Vice-presidents, H. H. S. Handy, Semet-Solvay

W. H. Childs, Barrett

E. L. Pierce, Solvay Process

W. H. Nichols, Jr., General Chemical

Secretary-treasurer, C. S. Lutkins, General Chemical

Assistant secretary-treasurer, T. E. Casey, Barrett

The Barrett Trail for January comments as follows on the chief executives of the Allied corporation and the new directorate of The Barrett Company:

"In Dr. Nichols, this great corporation has a worthy chairman, a man who has given fifty years of his busy life to service in a field in which he is still active; a man—it is not exaggeration to say it—who brought an industry into being, nursed it through infancy, endowed it with the dreams of boyhood, the ambition and strength of manhood, the foresight and wisdom of maturity, and who now sees the fruition of all his hopes and expectations from his post of high honor.

"One need not look far to realize what manner of man is Dr. Nichols. President of the American Chemical Society, in which he holds charter membership; president of the Society of Chemical Industry, president of the Eighth International Congress of Applied Chemistry—he has had every mark of distinction his contemporaries can give him. The Allied corporation is indeed fortunate in having such a man as its chairman.

"Orlando F. Weber brings to the presidency of the corporation every quality necessary for the successful conduct of its affairs. Leader in and organizer of America's dyestuff industry, he is peculiarly fitted to take up the tasks that await him.

"The first board of directors of the Allied corporation consists of the following men:

"W. H. Nichols, Sr., chairman; W. H. Nichols, Jr., E. L. Pierce, H. H. S. Handy, Eversley Childs, William Hamlin Childs, O. F. Weber, W. J. Matheson, Rowland Hazard, Armand Solvay, Roscoe Brunner, Emanuel Janssen.

DIRECTORATE CHANGES IN BARRETT CO.

"At a special meeting of the board of directors, held Dec. 17, Eversley Childs, chairman of our board of directors, and William Hamlin Childs, president of the company, tendered their resignations, coincident with the incorporation and organization of the Allied Chemical & Dye Corporation.

"Vice-President W. N. McIlravy was elected to succeed Eversley Childs, and Vice-President and General Manager T. M. Rianhard was elected to succeed William Hamlin Childs, who was made chairman of the executive committee.

"As was true of the retiring heads of the company, their successors are men who have been identified with the coal-tar industry—and therefore with The Barrett Co. or its predecessors—all their lives. Mr. McIlravy was associated with Mr. Childs in the Mica Roofing Co. practically from the start. Mr. Rianhard came to the company by way of the Warren Chemical & Manufacturing Co.

"At the same meeting, ten of the members of the board of directors resigned and eight men were elected to replace them. Those resigning were as follows: H. W. Croft, president Harbison-Walker Refractories Co., Pittsburgh; J. H. Fulton, vice-president National City Bank, New York; W. S. Gray, president William S. Gray & Co., New York; Dr. A. C. Humphreys, president

Stevens Institute of Technology, Castle Point; I. B. Johnson, vice-president Isaac B. Johnson & Co., New York; Powell Stackhouse, director Cambria Steel Co., Philadelphia; Hamilton Stewart, vice-president Harbison-Walker Refractories Co., Pittsburgh; J. H. Staats, New York; H. D. Walbridge, H. D. Walbridge & Co., New York, and H. S. Wilkinson, chairman Crucible Steel Co., Pittsburgh.

"The new members of the board include the presidents of three of the merging companies and five Barrett men, to whom, as with Mr. McIlravy and Mr. Rianhardt, their honors come as fitting recognition of years of loyal and efficient service.

"E. L. Pierce, president of the Solvay Process Co.; W. H. Nichols, Jr., president of the General Chemical Co., and Orlando F. Weber, president of the National

the Barrett Manufacturing Co. in 1902 as office manager. On Feb. 10, 1903, he was elected assistant secretary and assistant treasurer, and on Jan. 25, 1911, became secretary and treasurer of the company.

"D. W. Jayne, manager of our chemical department, began his connection with our company when he joined the department in November, 1902, assisting the superintendent at the Frankford plant. He was appointed assistant manager in 1907 at the time the office of the chemical department was moved from Grays Ferry to Frankford. Upon his father's death, in 1910, Mr. Jayne was appointed to succeed him as manager, and has continued in that capacity to the present time.

"Clark McKercher was a member of the United States Department of Justice before coming to the company in 1913. He has been our general counsel for seven years."



T. M. RIANHARD

Aniline & Chemical Co., together with H. H. S. Handy, president of the Semet-Solvay Co., who for some time has been a director, give representation to each of the other merger companies on our board.

"The five Barrett men elected to the directorate are well known to the Barrett organization.

"W. B. Harris is our general sales manager. He began his long service in 1896, when he joined the Mica Roofing Co., and later became salesman for the National Coal Tar Co. He next was associated with Mr. Rianhardt in the Warren Chemical & Manufacturing Co., finally becoming its general manager. In January, 1913, Mr. Harris was appointed manager at Birmingham, and in December of the same year he became Mr. Rianhardt's assistant in New York, later taking up his present duties.

"M. H. Phillips, manager of the New York branch of the company, has one of the longest if not the longest service record among our active employees, a brief account of which appears elsewhere in this issue in connection with the occurrence of Mr. Phillips' thirtieth Barrett birthday, Nov. 19.

"E. J. Steer is our secretary and treasurer. He joined



W. N. McILRAVY

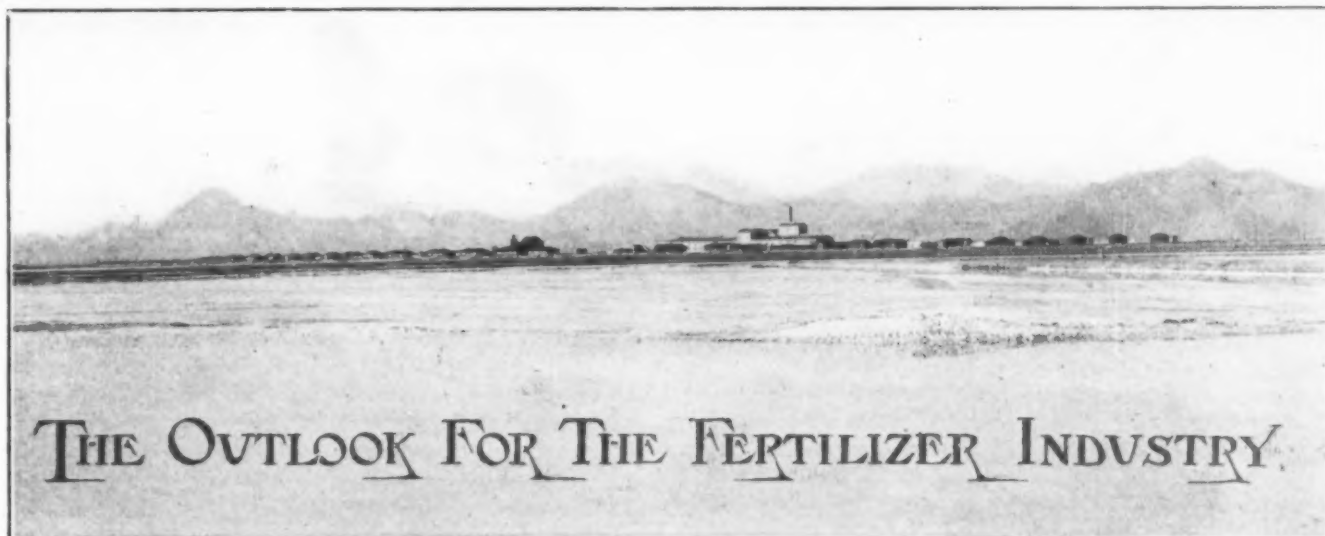
At a meeting of the board of directors of National Aniline & Chemical Co., Inc., held Dec. 21, Orlando F. Weber offered his resignation as president. J. W. Newlean was elected president of the company and Mr. Weber continues as chairman of the board of directors.

F. M. Peters resigned from the board and E. L. Pierce, president Solvay Process Co., was elected a director. B. A. Ludwig, C. F. Weber and Dr. L. H. Cone were elected vice-presidents of the company.

Judge Gary Sees Prosperity Ahead

Judge Elbert H. Gary, chairman of the board of the Steel Corporation, in a recent interview with newspaper men, reiterated his faith in the prosperity of the United States. He held the war responsible in great part for present economic conditions, but said that capital is also responsible in some measure, due to its use of "unreasonably, if not unfairly" increased fortunes.

Despite all these conditions and the alarmist views held by some, Judge Gary affirmed that prosperity is coming, just when he could not say, but surely coming.



THE OUTLOOK FOR THE FERTILIZER INDUSTRY

A Broad View of Both the Consumption and the Production Side of the Fertilizer Situation — Industrial Agriculture and Professional Farmers—Expansion in the Western States—
Inoculated Sulphur—Phosphate Rock—Potash and Nitrogen

BY FRANK K. CAMERON

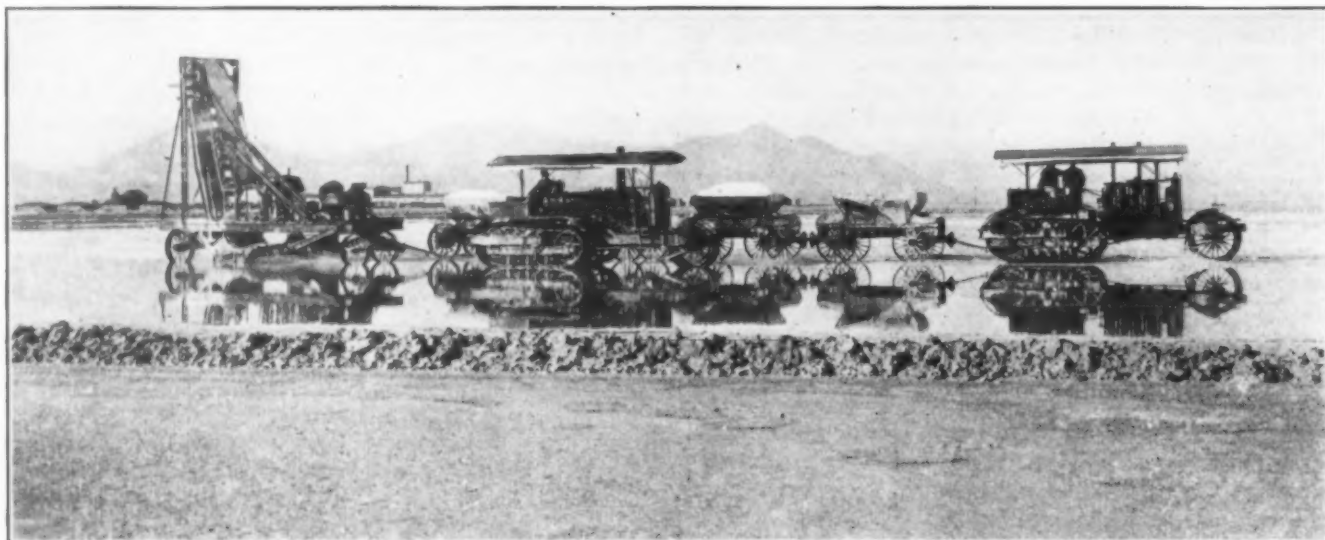
THE present status of the fertilizer industry is very favorable and the outlook is, on the whole, as alluring as for any other industry in the country. The fundamental needs of civilized man are food and clothes. Food and clothes are directly dependent on the management of the soil. In the conditions of society which have developed in the United States, cultivation of crop plants and therefore management of the soil imperatively must be far more intensive than hitherto. Of the primary instrumentations for these purposes, that which is most directly under man's control and susceptible of modification is the use of fertilizers; and fertilizers, to be economically used, must be manufactured or prepared for the user. Hence the industry is on a firm, sound, fundamental basis of universal human need.

The industry now possesses the public confidence. This is its greatest asset. It is worth while to accent the fact, for it has not always been the case. It is not proposed to discuss the mistakes of the past, for this is not a historical retrospect, but to attempt to analyze and visualize the present and immediate future. The reasons for the present gratifying relation of the industry to the public are many. Only a few of the more salient can be recounted within reasonable limits for a magazine article. Undoubtedly, the services of the industry during the war, especially that rendered by many of its prominent personnel, and in turning over sulphuric acid and other plant equipment to munition production, have been potent factors. But perhaps rather more or less consciously the industry has undergone a revolution during the war years and the succeeding period. Many of the changes were initiated before the war, it is true, but were hastened to actualities under its stress. We are only concerned, however, with the results and not their history.

In this day and generation, in the United States the old time-honored concept of farming is rapidly disappearing, being replaced by a recognition of a consid-

erable group of agricultural industries or distinct businesses, some of them very highly specialized, with highly developed technology, served by a highly trained corps of professional advisers with the same type of cultural training called for in the engineer, lawyer or physician, and requiring skilled labor. In fact the unskilled laborer is relatively of no more value today in farming occupations than in the mechanical industries or factory operations. Yokels do exist, it is true. So do cobblers. Both have their fields of usefulness as yet, but the one is of no more significance in American farming than is the other in the boot and shoe industry.

The fertilizer industry in the United States, now recognizing the average American farmer in his true aspect, is rapidly reorganizing to give him the service he requires. The older propaganda, deliberately founded on ignorance and prejudice and involving an enormous multiplicity of brand names regarded as the pride but really the curse of the industry, has been abandoned, the end hastened or forced by the inability of the manufacturers to obtain the necessary supplies of raw materials during the war. Most fortunately they have been replaced by a limited number of standard mixtures recognized by the trade as a whole and by state and federal agricultural authorities as well. And the industry has founded and supports soil improvement associations officered by highly trained specialists who, co-operating with other recognized authorities, public and private, truly and conscientiously endeavor to determine the needs of the individual or the community and, so far as the industry can, to supply these needs. In other words, the industry recognizes that true service pays better than merely pushing a brand name, and is profiting thereby. Again, the war conditions in this country brought the farmers generally a command of cash credit, enabling them to escape from the pernicious practice of purchasing their fertilizer on deferred credits based on crops yet to be



LOADING POTASH SALTS DEPOSITED FROM BRINE AT SALDURO, UTAH

planted, and at the same time enabled the industry to reorganize its selling methods so as to avoid as much as possible a resumption of this economically unsound system.

EXPANSION IN THE WESTERN STATES

Within recent months well-founded rumors have been current that factories for the production of commercial fertilizers are to be erected in Kansas City, in Sioux City, perhaps in Denver and Salt Lake City, and several new plants are definitely planned for the Pacific Coast. Recent tests in the intermountain regions by disinterested observers have shown that commercial fertilizers have markedly favorable results with sugar beets, canning crops and alfalfa. Even more remarkable, because unexpected, are preliminary reports on the use of fertilizers in dry land agriculture where the crops are small grains. Quite significant are the quite numerous inquiries for fertilizers during the past two years by farmers on Western lands, and the interest in them manifestly developing in the Dakotas, Colorado, Utah, Oregon and Washington will surely crystallize into active demands as soon as there is a reasonable prospect of the demands being met at reasonable cost figures. Credible observers in the business estimate that together with California they will probably require 150,000 tons of phosphate rock the coming year, and potash and nitrogen carriers in proportion. A noteworthy development in California is the long staple cotton. This year there are reported to be more than 400,000 acres planted to this high-priced crop in California, Arizona and New Mexico, and experimental acres throughout a large part of the San Joaquin Valley have proved uniformly successful, so that a very largely increased acreage is to be expected next year. In fact, this type of cotton promises soon to rank with citrus fruits in importance in California. Many planters from the Southern States are being attracted, men thoroughly imbued with the knowledge of the value of fertilizers in cotton culture, and a large market in that area seems assured. Therefore a much extended use with other crops, as familiarity of the community with fertilizers increases, seems very probable.

The supply of raw materials is the chief specter on the horizon, but only because of the difficulties of bringing them to the plant, for in amount they appear illimitable and of sufficiently diversified origin to pre-

clude any long-continued stoppage. The market demands are insistent and greater than the prospective production. So far as anyone can now intelligently guess the future, this condition is to prevail, so that ready sales and good prices seem assured for many seasons ahead.

INOCULATED SULPHUR

While the most striking feature of the present situation is the remarkable and happy reversal of public sentiment toward the fertilizer business, and the general improvement in the technology of the manufacturing operations is not much less striking, it must not be lost to sight that a third development has assumed very great importance in the immediate past—namely, a sympathetic consideration of possible new fertilizers and new forms of older established constituents.

Of the new proposals, attention must be called to sulphur. That sulphur might have an importance as a fertilizer has often been suggested, but these suggestions have been sporadic and commanded no general attention until Lipman's experiments with sulphuric acid in California. O'Gara's observations in connection with his investigations of the effects of smelter fumes on soils and vegetation and those of the Oregon State Experiment Station served to excite interest in the value of different forms of sulphur carriers and to prepare the public mind for the announcements of the elder Lipman at New Brunswick, who has shown what others had suspected but left for him to find the proof—that the value of elemental sulphur and presumably of combined sulphur is probably dependent upon the presence of particular bacterial organisms, and that these organisms are most efficient when other particular substances are present in desirable amounts such as organic debris and basic phosphates of lime.

These investigations have led to patented processes, and it is reported that one of the large sulphur producers in the Gulf fields expects to put on the market in the near future a mixture of elemental sulphur, phosphate rock and suitable organic matter impregnated by special strains of bacteria artificially bred to extraordinary efficiency in making effective the mixture when applied to the soil. There has been accumulated a sufficient body of apparently irrefutable evidence in the near past to make it appear that sulphur in various forms is sometimes very valuable as fertilizer on some

soils and with certain crops. As to how generally it may profitably be used probably no one knows today. Serious and capable technical studies are under way, supported by adequate commercial backing, and the interested public will in due time be properly advised as to the value of the new fertilizer.

CONCENTRATED FERTILIZER

For years, particularly by the Federal Bureau of Soils, attention was called to the necessity of considering the use of more condensed forms of fertilizers than those in common use. The continued rise in freight rates and in the costs of farm labor were the potent arguments, although there were others which appealed but little less strongly to the technically minded man. Uniformly, the foremost manufacturers of "complete fertilizers" took the ground that they favored higher grade goods than were then on the market, although their actual output did not lend much credit to this statement. But quite uniformly they always opposed putting mixtures of pure salts on the market by the statement that the farmer wished only the goods diluted with "filler" because he possessed neither the machinery nor the wits to devise means of distributing the very high-grade or pure salt mixes.

Times have changed. At least they are changing. *Double* superphosphates are on the market and are bought eagerly. A long step further, ammonium phosphates are in the fertilizer market and it is not a wild surmise that a few years hence will see most of the phosphorus marketed in this form. Eighty or 90 per cent potassium chloride is eagerly absorbed by the fertilizer trade when it can be obtained. Two of the largest chemical manufacturers in the country, it is reported, have made a combination which will put on the market during the coming year an enormous tonnage of ammonium chlorides, which they expect to be absorbed by the fertilizer trade on the ground that it contains a higher percentage of "available" nitrogen than any other compound made in sufficient quantity to use as a fertilizer.

SULPHURIC ACID

The aggregate production of sulphuric acid is probably now greater than 6,000,000 tons, calculated to a 50-deg. Bé. basis. If one is to credit all the current reports, this production will be greatly increased in 1921, for war stock accumulations will have totally disappeared by then, and there is to be a much increased production of phosphate rock, which will call for an increased production of acid to convert it into more soluble phosphates.

Certainly there have been erected some new and large sized plants, and others are more or less definitely promised in the near future, especially on the Pacific Coast. There are several large plants, notably those connected with the zinc smelters of the Middle West, which were practically completed when the armistice brought a sudden halt to munition manufacture, but which have not yet been put in operation.

The development of the Louisiana and Texas sulphur mines has been followed by an increasing use of this material in making sulphuric acid. Just what proportion of the acid produced in the country is from this origin is not definitely known as yet, but it is certainly large and probably will remain large. The domestic consumption of sulphur is approximately 875,000 tons. How much is used for making insecticides and products

other than sulphuric acid seems not to be known definitely, but the bulk of the production goes into the manufacture of the acid. Probably 50 to 60 per cent of the sulphuric acid now going on the market is made wholly or in part from elemental sulphur. On the average the acid now produced is better than hitherto. Another feature of the present development is that a very much larger proportion of the acid made now is in the form of 60 deg. Bé. or stronger, because it must be shipped in tank cars to the mixing plant. Increased skill in the handling and mixing with rock has resulted.

PHOSPHATE ROCK

In the United States the use of bones, basic slag, etc., is too limited to have any particular significance for the industry as a whole. The chief sources of supply for the phosphate of fertilizers are the rock deposits of Florida, Tennessee, the Western field and perhaps Charleston.

Florida easily holds the first place. It produced about a million and a half tons in 1919, or less than half the tonnage for 1913. The production was considerably curtailed by strikes and transportation difficulties, and of course exports were greatly reduced. If more rock could have been produced, the domestic market would have absorbed it. It is confidently expected that returns for the present year will show a considerable increase and that the industry will soon resume its former proportions. A noteworthy fact is that the restricted exports have sent much of the highest grade rock to the domestic manufacturers and these latter will probably insist on using it in the future.

Like Florida, the Tennessee field has had its labor difficulties, and claims to have suffered particularly from inadequate transportation facilities. Its production in 1919 was about 460,000 tons and it is expected to show an increase for the present year.

The Charleston field, which appeared about to be abandoned because of mounting costs of operation and low grade of rock recovered, showed an increased production in 1919. About 100,000 tons of 60 per cent b.p.l. rock was marketed. Because of continued shortage in the Florida supplies it is expected that Charleston may do as well the current year.

DEVELOPMENTS IN THE WESTERN FIELD

The important developments have been in the Western field. The Anaconda Copper Co. is now producing double superphosphate, making sulphuric acid from smelter fume in a Larison packed cell plant, and obtaining the rock from the company operating at Paris, Idaho. The Anaconda company has added to its phosphate rock holdings at Melrose and Garrison, Mont., a large deposit in Soda Springs Canyon, Idaho, and is assembling a large mine and milling equipment, and a railroad is being built from the main line of the Oregon Short Line at Soda Springs to its proposed workings.

The Western Phosphate Co.'s mine, about three miles from Paris, Idaho, is connected by rail with the Oregon Short Line main line at Montpelier. The rock taken from this mine is white or light gray in color and appears to be very uniform in composition, the dried rock analyzing better than 72 b.p.l. It is claimed that the vein from which this rock is taken is 6 ft. in width and it has been traced for nine miles on land owned or controlled by the company. The other rock in the Western field is brown or black in color, usually harder

than the Paris rock and lower in phosphorus content, although there are some very large veins much higher in phosphorus content.

The Western Phosphate Co.'s main tunnel has now been driven about 2,000 ft. on this vein. The company has established a camp with large mining facilities, has a mill for crushing and drying with a daily capacity of 350 tons, another under construction with a daily capacity of 400 tons and a fine grinding mill with a capacity of eighty tons daily. The company has been shipping continuously since April of the current year to the Middle Western States, to the Pacific Coast and to the Orient. For the latter trade large loading bins have been constructed at Portland, which has handled the bulk of the export trade. The Western Phosphate Co. is associated with the interests controlling the large high-grade deposits near Border, Wyo., and in the Crawford Mountains, Utah, the largest reserves of high-grade rock in the world. The American Phosphate Co. is working a deposit about five miles from Montpelier and is reported to be producing about sixty tons a day with an augmented production promised at an early date, and there are several other shippers of small tonnages in the area. The total shipped from this area in 1919 was about 16,000 tons. The current year will probably see this figure quadrupled, the bulk of the material being taken from the mine at Paris, and as the black rock is rapidly winning friends as its merits become known to the trade, a steadily increasing production from this field can be expected. The long delayed but apparently now assured future of this industry will be a potent factor in developing the early manufacture and greatly increased use of mixed fertilizers in the Western States.

EXPORTS OF PHOSPHATE ROCK

The export of phosphate rock, which approximated 1,500,000 tons in 1913, gradually fell to less than a tenth of this during the war, but commenced to pick up as vessels for its transport became available, being 143,455 tons in 1918, about 380,000 tons in 1919, and will undoubtedly show a substantial increase for the current year. The bulk of the exports are from Florida, and go at present mainly to northern European ports. Japan has become a large buyer, and promises to increase its demands, especially upon the Western field.

The continued high price of sulphuric acid has served to direct more attention during the past year to other possible means of producing phosphoric acid. Volatilization of the pentoxide from the electric furnace, it is now pretty generally accepted, is technically simple and efficient, but not commercially practicable without much cheaper power than is now available. Waggon's experiments at the Washington laboratory of the Bureau of Soils, in volatilizing from a furnace similar to an ordinary iron blast furnace, appear to promise that a commercially economical process can be developed. While the process has been devised with the waste phosphatic materials of Florida in mind as the raw material, it would seem to lend itself particularly well to the phosphates of the Western field and the conditions there encountered.

There has been a very considerable interest in more concentrated forms than the ordinary superphosphate containing 16 to 18 per cent soluble phosphoric acid. Several organizations are now marketing "double" supers containing as much as 50 per cent soluble phos-

phoric acid (P_2O_5) and approximating pretty nearly the composition of pure monocalcium phosphate. Some confusion has arisen because certain interested parties have described these more highly concentrated phosphates as "treble" superphosphates because they contain three times as much "available" phosphoric acid (P_2O_5) as do ordinary superphosphates.

AMMONIUM PHOSPHATES

There is a growing interest in ammonium phosphates. The American Cyanamid Co.'s several grades of "amophos" have proved that such compounds are very valuable from technical considerations, but the relative scarcity and high price of ammonia since the armistice has checked the developments in this direction. It would appear to be far more advantageous to market ammonia as phosphate rather than as a sulphate. Naturally, the coke-oven installations, which are the principal producers of ammonium sulphate, hesitate to make the change, largely because they fear that it would involve a more or less complete scrapping of their present equipment. The writer's own experiments have convinced him, however, that only very slight modifications would be desirable and that it will be but a short time before much of the phosphoric acid used as a fertilizer will be supplied the trade in the form of ammonium phosphates.

THE POTASH SUPPLIES

Supplies of potash are yet far below the demand, and at the present writing there is a tendency toward higher prices, although there is a prospect of improvement in the quantity coming from abroad and produced from domestic sources. During 1919 about 112,000 tons of potash salts was imported, practically all of it in the second half of the year, and the importations for the present year will undoubtedly show a very considerable increase. But in the writer's opinion it will be some years yet before imports can be expected to reach pre-war figures, or before prices will be materially lowered. He does not expect that prices will approach pre-war levels for many years, if ever.

Neither France nor Germany has any interest in furnishing potash to the United States, other than the money return or its equivalent in commodities. They are likely to recognize no other inducement than a large money return. The money value of the total potash imports of the United States in 1913 was just about \$15,000,000. At present prices this importation would be worth just about \$50,000,000. But present prices would certainly not exist if such quantities were actually available. Probably \$30,000,000 would be a liberal estimate of the value of the importation to the United States, and it would cost more than half this figure to mine and land the salts in the United States. To one who has kept in touch with the actual operations in the French and German fields it seems quite unlikely that either could command much more than half the American market if the other chose to compete.

The total probable realizable return from the American market is not, therefore, particularly attractive to either the French or the German authorities, and under the internal conditions in both countries it is more desirable, from their viewpoints, to maintain high prices and furnish a much restricted tonnage. France desires above all things in an industrial way to become Europe's master producer of iron and iron products,

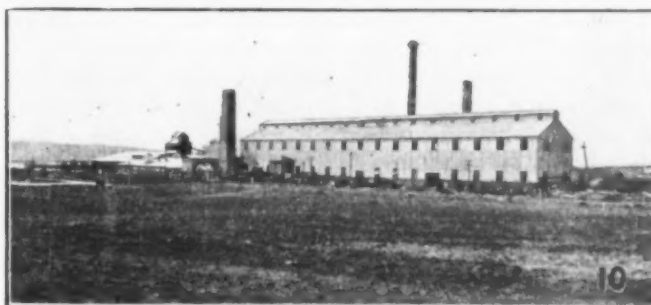
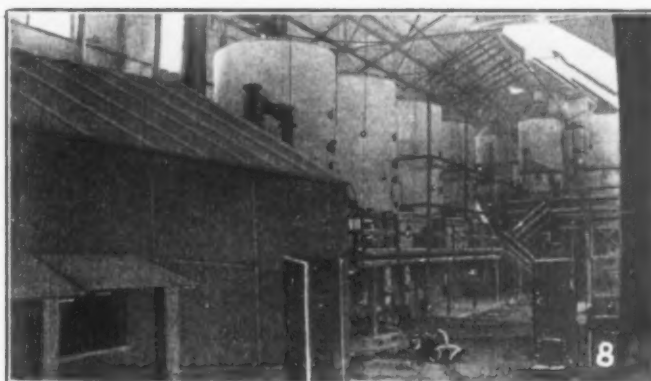
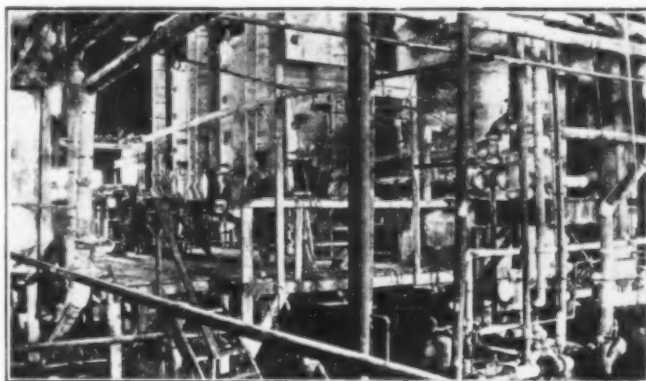
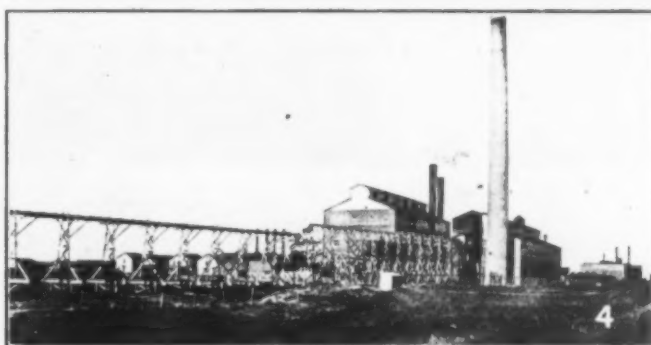
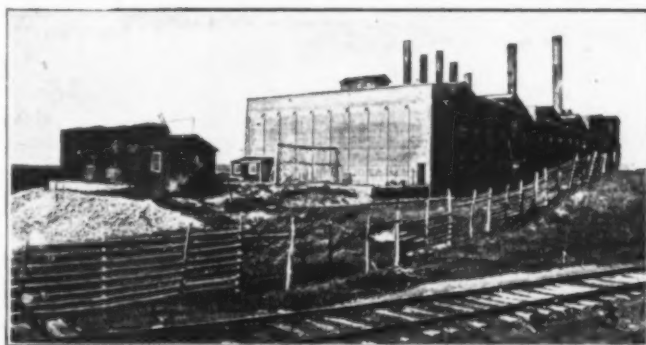
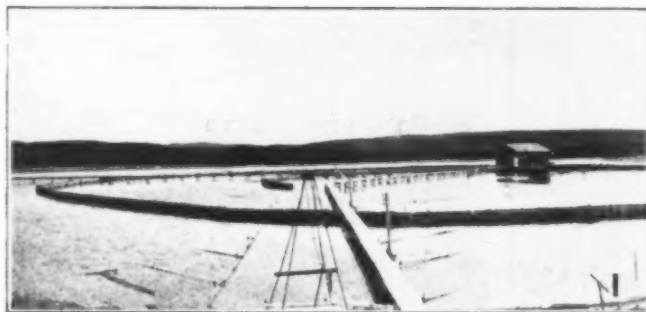


Fig. 1. Plant Lake, Standard Potash Co. Note spiral draw-to and solar evaporation by slow flow of water.

Fig. 3. National Potash Co.

Fig. 5. Rotary kilns in operation.

Fig. 7. Evaporators, Standard Potash Co.

Fig. 9. Nebraska Potash Co.

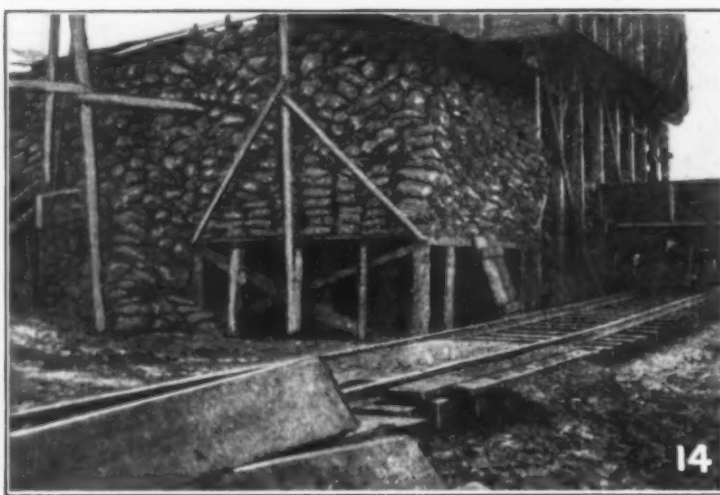
Fig. 2. Typical lake, sand dunes in foreground.

Fig. 4. Western Potash Co. Antioch works.

Fig. 6. American Potash Works.

Fig. 8. Evaporators, Hord Co.

Fig. 10. The Hord Co. Lakeside plant.



WESTERN PHOSPHATE CO., PARIS, IDAHO

Fig. 11. Snow shed, mine portal to mill.
Fig. 13. Mill and bins.

Fig. 12. Loading bins.
Fig. 14. Fine ground rock bagged.

and she is woefully short of man labor. She does not, therefore, look with favor on permitting any miner to work in the potash mines of Alsace who can be employed in the iron mines of the Briey, Lorraine or the Saar, or the coal mines of Lens. At the same time she is not going to permit Germany to build up the potash export trade at her expense. On the other hand, Germany has troubles of her own. The potash mines are now largely in the control of the laborers themselves. Production is not particularly remunerative or attractive. Repairs and renewals have not been kept up. Transportation facilities are wretched. Labor appears more necessary to other industries and the other industries appear more attractive and remunerative. The old trained crews are broken up.

On the whole, it seems probable that for years to come both countries will produce their own requirements and small surpluses for export, but that America's hopes of obtaining any large part of this surplus is only by paying what appears to us as exorbitant prices. Consequently, we shall have to develop our own resources or remain content to use much less potash than appears to be the plain requirements of the country.

DOMESTIC PRODUCTION OF POTASH

In 1919 our domestic production was approximately 120,000 tons of salts containing 32,418 tons of actual potash (K_2O), this being less than 60 per cent of the production of 1918. The falling off was due mainly to

the apprehension of a great influx of foreign potash at cheap prices. Many enterprises were completely abandoned; but, as the expected flood of foreign salts failed to materialize, the stronger and better organized enterprises resumed operations and the current year will probably show a production equivalent to more than 100,000 tons of actual potash (K_2O). If the writer's judgment continues to be confirmed by the size and cost of the foreign imports through the coming fall season, it is reasonable to predict a greatly increased development of domestic resources during the coming year, and it would not be surprising to see the 1921 production approach an equivalent of 250,000 tons of actual potash, the pre-war annual requirements of the country. It is certainly true that the interest in American "potash" is much more keen today among the larger fertilizer manufacturers and that the prejudice that formerly existed against it, largely because some of the Western salts contained appreciable quantities of borax, is fast disappearing, since the producers have learned how to avoid this objectionable constituent.

POTASH SALTS FROM SALINES

The principal interest in the domestic production during the current year has been in the recovery of potash salts from salines. In Nebraska some of the ponds which had been pumped out and apparently exhausted in 1919 filled again with the snow and rains of the following winter and were found to contain again

workable quantities of potash salts to an extent little or no less than formerly. All theories that this field will be exhausted within a few years have been abandoned, and there is greater activity there than ever before. The practice in the larger plants has become standardized. The brine from the outlying ponds or lakes is pumped to a near-by "plant pond" through wooden pipe lines and discharged in such a way that there is a current produced in the pond, the surface is kept in motion and there is more or less spontaneous evaporation. Evaporation by sprays and towers is not attempted, as the consensus seems to be that drift losses would be too great. The brine is taken from the bottom of the plant pond, through ordinary sand points with ordinary iron centrifugal pumps, to multiple effect evaporators and is concentrated to a solution of about 31 deg. Bé. hot, when it flows or is forced into a revolving iron tube, countercurrent to an oil flame and desiccation completed. Dust losses appear to be small and recovery of them efficient. A serious trouble is the sticking of the drying salts to the shell of the rotating tube. Rails are sometimes inserted to break the salts loose. Common practice is to have a workman walk back and forth on a platform and strike the rotating tube or kiln with a sledge. The desiccated salts are shipped as they come from the drier. They consist of a mixture of the sulphates, carbonates and chlorides of potassium and sodium with more or less organic and siliceous matter. Sulphate of potash is the predominating component, the potash content running generally from 27 to 30 per cent, sometimes higher. The operations are, it must be admitted, quite crude and readily susceptible of improvement. What has been accomplished elsewhere with American brines makes it reasonably certain that a phase rule study of the brines would soon and easily lead to modifications of the process that would produce a high-grade potassium sulphate and a merchantable sodium carbonate, with an increased value to the plant output.

OPERATIONS AT SALDURO, UTAH

At Salduro, Utah, the brine is gathered in an extensive series of ditches and conducted to shallow ponds, where it evaporates spontaneously, depositing a crystalline mass of potassium and sodium chlorides and leaving a concentrated mother liquor containing magnesium chloride with a very little of the chlorides of the other two bases. When the mother liquor has reached the desired concentration the deposited salts are harvested. A tractor pulls through the brine a buggy fitted with a scraping device which harrows the salts and draws them to the foot of an elevator. A second tractor draws, at the same time, a line of buggies into which the elevated salts are discharged, being washed and drained in the operation. The harvested salts are drawn to a stockpile at the near-by refinery. Accumulated mother liquors nearly saturated with magnesium chloride are stored in special ponds. The refining of the potassium chloride is effected by treating the mixed chlorides with a hot saturated solution of sodium chloride, the resulting clear liquor being then run into crystallizers, which are shallow iron pans fitted with brine pipes so that cooling can be hastened by artificial refrigeration. The surface of the brine pipes is kept clear by mechanical scrapers, which also gather the precipitated potassium chloride. A product of practically any desired commercial degree of purity can

thus be prepared. The reputed operating costs per unit of potash produced are low as compared with other enterprises in this country.

DEVELOPMENTS AT SEARLES LAKE, CAL.

At Searles Lake, San Bernardino County, Cal., there are three operating plants and another is in early stages of construction. One of the operating plants is following a solar evaporation scheme, and treating the resulting salt mixture. It is offering salts to the market, hence one may infer that it has developed a successful technique. The principal producer is the plant of the American Trona Corporation, which appears to have passed successfully a long and expensive pioneering campaign and emerged with a good economical process founded upon a careful, comprehensive, scientific investigation of the possible equilibria conditions in the brine which impregnates the twelve square miles of salt body in the lake. Although the level of this brine varies from a depth of a few inches above the level of the salt body in winter to a few inches below in summer, the brine does not vary in composition appreciably, if drawn from near the bottom of the salt body, the latter reaching a depth of 100 ft. or more in places. The brine contains chlorides, sulphates, carbonates and borates of potassium and sodium, being presumably saturated with respect to these salts and such combinations of them as can exist at the temperature of the bottom of the lake or salt body. On evaporation, which is carried out countercurrent to the stream flow in a multiple effect, sodium chloride, with other salts, is precipitated. The resulting hot mother liquor is then cooled quickly and quietly by artificial refrigeration, when potassium chloride is precipitated as a crystal meal. This meal is then washed and dried in a centrifuge, yielding a salt of 90 to 95 per cent purity and containing not more than a trace or inconsequential amount of borax. The mother liquor from the potassium chloride crystallization is then agitated, when a crystal mass is precipitated, which, when dissolved in a minimum amount of water, filtered and cooled, deposits a crop of very high-grade borax crystals. This last crop is augmented by passing air containing carbon dioxide through the liquor. It is possible that high-grade carbonates of soda will be added to the regular output of the plant. At present the grade of potassium chloride produced by this plant is so high that the entire output is absorbed in the alkali industry. Its output will shortly be tripled following plant readjustments now in progress, and it will then probably be an important factor in the fertilizer industry.

OPERATIONS ELSEWHERE

The production of potassium sulphate of a very high grade by the plant of the Armour Fertilizer Works at Marysvale, Utah, where the mineral alunite is roasted and leached, is now reported to be about fifty tons daily following enlargements and improvements of plant equipment. There is a renewed activity in alunite projects the past few months, but no other development worth recording.

Aside from cement mill operations, there is little to note in the production of potash salts from silicate rocks. The great hopes of last year that this one would see a large production of soluble potash salts from leucite have not materialized. The process tried out on a large scale at Green River, Wyo., was found to

be unsuited to plant operations as planned, although a number of carloads of a high-grade muriate were produced and shipped before an accumulating deficit in their financial resources forced its backers to suspend further efforts to modify it to meet equipment limitations. New methods for utilizing this source of potash are known to be under investigation by at least two large commercial organizations. Kelp as a source of potash is of vanishing importance at present, but not necessarily permanently. Other domestic sources of potash are not at present of sufficient relative importance to call for special notice or comment.

THE NITROGEN SUPPLY

The nitrogen supply will, in the main, continue to be cottonseed meal for some time to come, but it seems to be inevitable that this material will more and more be consumed as an animal food as feeders learn better ways of so using it. The same thing will be true of blood, tankage and fish scrap. Base goods or that indefinite conglomeration produced by treating organic waste such as leather scrap, feathers, etc., with sulphuric acid, will, however, continue to be used to greater and greater extent. Such ingredients are now frequently incorporated directly with superphosphate as the rock is mixed with the acid. There are prospects of an increased production of ammonia from byproduct coke ovens and it seems reasonably certain that there will be a much increased importation of nitrates from South America. But the greatest interest is and will continue to be in the artificial production of fixed nitrogen from the illimitable stores in the atmosphere. It may be frankly admitted that the high hopes developed during the war have not been realized by a wide margin. It would be foolish to assume that they will not be so realized sooner or later, and it seems only reasonable to expect that means will be found to continue the investigations of the last few years until it can be determined which of the various processes can properly survive under ordinary peace conditions in the United States.

To discuss satisfactorily the recent work on the various processes for fixing atmospheric nitrogen and the apparent merits or demerits would require a separate article and will not be attempted here. So far as the immediate interest of the fertilizer trade is concerned, two instances are apparently of dominating importance. A way must be found to proceed with actual production at Muscle Shoals, Ala., which will not involve unjust or injurious competition between the Government and established private enterprises. It should not be difficult for reasonable men to devise a plan which would ultimately redound to the interests of all concerned.

WORK ON MANUFACTURE OF AMMONIUM CHLORIDE

Perhaps the most striking announcement of the year is that the General Chemical and the Solvay companies have united to build a large plant for the production of ammonia by the Haber process, a desirable and economical adjustment of products of the Solvay and Haber processes having been worked out. As a result a very large tonnage of ammonium chloride will soon be on the market, which will readily be absorbed, it is expected, by the fertilizer manufacturers. A similar development is going on in England, where the Mond and Solvay interests are united for the purpose. It is reported that in France, where the scheme of adjust-

ing the two processes to each other's needs was first worked out, the problem of disposing of the large production of ammonium chloride as a fertilizer was carefully studied with pot and plot tests, with quite satisfactory results.

POSSIBILITIES FOR USE OF AMMONIUM CHLORIDE

Possibly there are some crops with which it would be inadvisable to use ammonium chloride. Tobacco is a case where one would be suspicious until actual tests are made. But for crops in general there seems to be no reasonable doubt that ammonium chloride would serve as well as any other salt as a carrier of nitrogen. An advantage is claimed for ammonium chloride, that it is the most concentrated form of ammoniacal nitrogen that can possibly be made commercially available. Of course ammonium nitrate contains an even higher percentage of nitrogen, all available for plant nutrition, but there is no prospect of this salt coming into use extensively in this country until there is much cheaper power than is now available, or ocean freights from Norway far lower than now seems probable. Whether the new salt will delay the development of plans to put ammonium phosphates on the domestic market is also an interesting question which can not be answered immediately.

SUMMARY

The most important developments of the current year, for the fertilizer industries, are:

The very great gain in public confidence.

An increased use of fertilizers in the Western States.

The opening of the Western phosphate deposits.

The revival of domestic production of potash.

The preparation for an early production of fixed nitrogen on a large scale as a byproduct of the soda industry.

The resumption of an export business.

The trials and tribulations of a reconstruction period have been met satisfactorily, on the whole, and the industries will be the stronger in the future for the lessons forced upon them.

Development of Egg-Products Industry in China

Perhaps no single industry has developed more rapidly in China than has the production of egg products during the war period. The eggs were collected in small factories formerly, but now these have become larger and are situated in the commercial centers, to which places the raw egg is brought in very large quantities. In 1913 there were exported from all of China 20,796,400 lb. of albumen and yolk and 30,266,845 dozen eggs, while in 1919 there were exported 80,824,267 lb. of albumen and yolk, 28,843,416 dozen eggs and 25,094,133 lb. of frozen eggs. These exports were valued at \$4,350,290 in 1913 and \$33,883,259 in 1919.

Many factories with the most modern equipment have been located in the various parts of China, Shanghai being the most important point, and Nanking, Hankow, Suchow and other places having manufacturing plants of considerable consequence. The exportation of frozen eggs is going forward in increasing quantities, and this article reaches the American as well as the European market. It cannot be shipped to the American market in the quantities that the desiccated egg can be, as it requires refrigerating vessels, which are not frequently run on the Pacific.

Notes on Nickel

Brief Notes on the Metallurgy of Nickel, and Data on the Uses and Applications of Various Grades—Information on the Limitations in Rolling, Annealing, Welding and Electrodeposition

By PAUL D. MERICA*

FOR the past two years the author has been interested in the collection of accurate information and data concerning nickel and its alloys and in view of the increasing importance of this metal both in the pure form and as an alloying element in the composition of many interesting alloys has deemed it of sufficient value to present some of this material in a series of articles. Although certain phases of this subject have previously been presented in a very satisfactory manner,¹ much information which should be very useful is still in such scattered form as to be rather unavailable. It has been the attempt to pay particular attention to those chapters of which this was true as well as to include a great deal of data particularly on nickel and its alloys other than nickel steel which has hitherto been unpublished.

Much assistance has been had in the collection of this material, for which the author wishes to make grateful acknowledgment: to A. J. Wadhams and J. F. Thompson of the International Nickel Co., to W. H. Bassett of the American Brass Co., to W. B. Price of the Scovill Manufacturing Co., to W. Blum of the Bureau of Standards, and to the Driver-Harris Co., the Electrical Alloys Co. and the Hoskins Manufacturing Co.

SOURCES

The ores from which commercial nickel is obtained are of three classes: (1) *Sulphides*, represented by the pyrrhotite-chalcopyrite ores of Sudbury, Canada, and of Norway, and which contain from 1 to 3 per cent each of copper and nickel, with the mineral pentlandite as the nickel carrier. (2) *Silicates and oxidized ores*, which are found principally in New Caledonia and contain from 5 to 6 per cent of nickel (plus cobalt), with garnierite as the principal nickel carrier. (3) *Arsenical ores*, which are found in Canada and on the Continent, in Saxony, and elsewhere. Of these, the first two classes only are of much commercial importance, and the first class furnishes by far the greater proportion of the present output of this metal. In addition to the metal produced from these ores, a small amount of nickel is recovered annually from blister copper.

SMELTING

Sulphide ores are first roasted and then smelted in blast furnaces to a matte containing approximately 24 per cent of nickel plus copper, 45 per cent of iron,

and the remainder sulphur. This matte is then blown in a converter to a mixture essentially of nickel and copper sulphides, which is ready for the refining.

Although the smelting practice of the companies operating with sulphide ore of the Sudbury type is essentially the same, as well as the product (which is usually known as bessemer matte), the refining of this matte to metal and the separation of the nickel and copper are accomplished by quite widely different processes, of which the following three are the most important:

REFINING

(1) The Hybinette process, which is in operation in Norway, is essentially an electrolytic one. The matte is roasted to remove the bulk of the sulphur and leached with 10 per cent sulphuric acid, whereby a large proportion of the copper with very little nickel is dissolved out. The residue is melted and cast into anodes, containing about 65 per cent nickel and from 3 to 8 per cent sulphur. These anodes are then treated by electrolysis, with cementation of the contained copper by anode scrap. In this manner nickel cathodes and both cement and cathode copper are obtained.

(2) In the Mond process (which is operated in England) the bessemer matte is first roasted and the copper removed in part by leaching with sulphuric acid with the formation of a solution of copper sulphate. The residue, containing nickel oxide with some copper oxide and iron, is reduced at a low heat to a finely divided metallic powder. This is carefully protected from contact with the air, and carbon monoxide is passed over it at from 50 to 80 deg. C. At these temperatures nickel-carbonyl vapor is formed, later to be decomposed by passing it through a tower containing shot nickel heated to about 200 deg. C. A layer of nickel is formed on the shot and the carbon monoxide is regenerated and returned to the volatilizing towers. The nickel shot is alternately exposed to and withdrawn from the action of this gas and in this way a series of concentric layers of nickel are built up around the original nucleus, like the coats of an onion, a means of ready distinguishment.

(3) The Orford process, which is the oldest process for the separation of copper and nickel, is being operated in this country. The bessemer matte is melted with salt cake, or niter cake, together with coke in the blast furnace. The sodium sulphide formed by the reduction of the sodium sulphate by the coke together with the copper sulphide forms a matte of low specific gravity. The product of the blast furnace is allowed to cool in pots, in which a separation occurs, the upper portion or "tops" containing the greater part of the copper sulphide together with the sodium sulphide, the lower portion or "bottoms" containing the greater part

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¹Superintendent of Research, International Nickel Co.

²"Physical Properties of Nickel," by D. H. Browne and J. F. Thompson, *Bulletin, A.I.M.E.*, August, 1919. Report and Appendix of the Royal Ontario Nickel Commission, A. T. Wilgress, Toronto, 1917. "Manufacture and Uses of Alloy Steels," by H. D. Hibbard: John Wiley & Sons, N. Y., 1920. "Die Spezialstähle," by G. Mars; Ferdinand Enke, Stuttgart, 1912. "Steel and Its Heat Treatment," by D. K. Bullens; John Wiley & Sons, N. Y., 1918.

of the nickel sulphide. The "tops" and "bottoms" are readily split apart when cold. Several treatments are required to effect a sufficiently complete separation. The "tops" go to the copper cupola and converter, where they are blown to blister copper. The "bottoms," consisting essentially of nickel sulphide or matte, are roasted and leached alternately until they have been completely changed to nickel oxide. This is reduced with charcoal in crucibles or reverberatory furnaces to metallic nickel at a temperature above its melting point such that the resulting product may be cast into ingots or blocks or poured into water to form shot. Electrolytic nickel is also produced by casting this reduced metal at once into anodes, and obtaining pure nickel cathodes from them by electrolysis with an electrolyte of nickel sulphate.

The silicate ores of New Caledonia, which contain no sulphur, are first mixed with sulphur-bearing materials such as gypsum or pyrites and smelted in the blast furnace to a matte, which is shipped for refining, which in this case, in the absence of copper, consists merely of roasting the nickel matte to oxide and reducing the oxide with charcoal.

COMMERCIAL GRADES

Nickel appears on the market in the following forms:

(a) Grains, cubes, rondelles or powder reduced at a low temperature from nickel oxide and not fused in the process of manufacture.

(b) Nickel deposited in concentric layers from nickel carbonyl and not fused in the process of manufacture.

(c) Nickel deposited electrolytically in the form of cathode sheets.

(d) Nickel in the form of blocks or shot made by reducing nickel oxide above the melting point of nickel and casting the resulting molten metal or pouring it into water.

(e) Malleable nickel made in the same manner as (d) but treated with some deoxidizer before pouring into ingots. This nickel appears in the usual commercial forms—i.e., rods, sheet, wire, etc.

Most of the commercial production of nickel falls in class (d).

The International Nickel Co. has described the grades of material which it produces and contributes the average analyses of these materials found in Table I.

"A" shot nickel is a high-carbon nickel used by manufacturers of anodes for nickel plating.

"X" shot nickel is a purer material used by the manufacturers of crucible nickel steel and of nickel silver.

Ingot or block nickel is almost identical in composition with "X" shot. It is sold in 25- and 50-lb. blocks or ingots and is used in the manufacture of open-hearth and electric steel.

Electrolytic nickel in the form of cathodes 24 x 36 in., weighing about 100 lb., or in smaller squares, is used in the manufacture of high-grade nickel silver and cupro-nickel alloys.

Malleable nickel intended for rolling into sheets or rods or for drawing into wire is made in various grades according to the purpose for which it is destined. All malleable nickel is treated before casting into ingots with some deoxidizer, generally magnesium, for the purpose of removing the nickel oxide present and making the metal suitable for rolling or forging. Manganese is also added both for the purpose of cleaning the metal and as an alloying element. Nickel cannot in general be rolled or forged without this preliminary treatment with a deoxidizer.

Grades A and C malleable nickel ingots are produced by the International Nickel Co. for rolling into rods and sheets and drawing into wire.

Grade D malleable nickel is high-manganese nickel having practically the same analysis as grade C

TABLE I. COMPOSITION OF VARIOUS GRADES OF COMMERCIAL NICKEL

Name	Source	Form	Cu	Ni and Co	Co	Fe	S	Si	C	Mn	As	Sn and Sb	Insol.	Remarks
Nickel rod	H. Boker & Co.	Rods	0.18	97.58		0.38	0.012	0.13	0.19	1.60				
Malleable nickel A	International Nickel Co.	Rods		99.00		0.55	0.025	0.10	0.15	0.15				Typical analyses Orford Works
Malleable nickel B	Int'l Nickel Co.	Rods		98.75		0.50	0.025	0.20	0.15	1.75				Typical analyses Orford Works
Malleable nickel C	Int'l Nickel Co.	Rods		96.75		0.75	0.03	0.20	0.15	1.75				Typical analyses Orford Works
Nickel castings	Int'l Nickel Co.	Castings		98.95		0.50	0.035		0.16					Typical analyses Orford Works
Nickel sheet	Fleitmann Witte & Co.	Sheet	0.12	99.37					0.019					
Malleable nickel	Krupp (Germany)	Sheet No. 1	0.12	99.26		0.40	0.024	0.17	0.045	trace				
Rolled nickel sheet	Boker and Co.	0.0001 x 12 in.	0.12	97.99	0.88	0.49				1.32				
French 25 centimes	France	Coin	0.083	99.26	1.36	4.05	0.05	0.07	0.042	trace	0.018	0.021		
20 centimes piece	Italy	Coin	0.089	99.23		0.31				0.17				
Arthur Krupp	Berndorf Austria	Wire rod	0.10	99.20	0.54	0.40	0.01	0.02	0.07	0.22				
Nickel rod	England	1/4 in. wire	0.23	99.13	0.62	0.30	0.022	0.06	0.16	0.66				
Electro malleable nickel	Driver-Harris	0.081 in. wire		98.47		0.80	0.06	0.16	0.13	0.30				
Malleable nickel	Fleitmann Witte & Co.	Wire		98.60	trace	1.22				0.16				Royal Ontario Nickel Com'n
Metallic nickel	U. S. Nickel Co.	Various	0.05	99.02	0.12	0.21	0.025	0.21	0.39	trace				
Pure nickel	Kalmus & Harper			99.29	nil	0.48	0.025	0.042	nil					Royal Ontario Nickel Com'n
Nickel	New Caledonia		0.50	98.00		1.60		0.13						Royal Ontario Nickel Com'n
Nickel	Basse & Selve		0.10	97.87	1.45	0.45	0.05	0.19	trace					Royal Ontario Nickel Com'n
Nickel	Deloro Mining		0.05	98.00	0.80	0.75								Royal Ontario Nickel Com'n
Norway nickel	V. Hybinette	Electro	0.06	99.52	0.89	0.36								
Orford nickel	Intern'l Nickel Co.	Electro	0.01	99.84			0.005		0.005		0.01	0.01	0.003	Analyzed by Orford (1908)
Electrolytic nickel	Hybinette process	Electro	0.10	98.75		0.50	0.01							Royal Ontario Nickel Com'n
Nickel shot	U. S. Nickel Co.	Shot	0.06	98.98	1.01	0.58	0.006	0.19	0.16		trace	0.003		
Mond nickel	L. Mond (England)	Shot	0.03	99.36	0.06	0.39	0.002	0.11	0.11	0.09				
Mond nickel	Mond Nickel Co.	Shot	None	99.80	None		0.006	None	0.05					Analyzed by Hadfield (1899)
Nickel shot	Intern'l Nickel Co.	A shot	0.15	98.65	0.80	0.50	0.06	0.15	0.45		0.015	0.015		Analyzed by Orford (1914)
Nickel shot	Intern'l Nickel Co.	X Shot	0.15	99.05	0.80	0.47	0.04	0.10	0.18		0.015	0.015		Analyzed by Orford (1914)
Nickel cubes	U. S. Nickel Co.	Cubes	0.065	99.16		0.32			0.41					
Metallic nickel	Le Nickel	Cubes		99.41			0.015	0.04	0.176					
Grain nickel	Am. Nickel Works	Grain	0.13	99.17		0.51							1.06	
Mond nickel	Ludwick Mond	Grain	0.014	99.57		0.133	0.003		0.23		trace	trace	0.03	
Metallic nickel	Le Nickel	Grain		99.38			0.010	0.109	0.048	0.01				
French nickel	Le Nickel	Rondelle	0.112	99.01		0.43	0.024		0.037					
Nickel ingots	Intern'l Nickel Co.	Ingots	0.11	99.09	0.32	0.65	0.04	0.01	0.04		0.02	0.02		Analyzed by Le Nickel (1905)

NOTE.—The nickel values of some of the samples mentioned by the Royal Ontario Nickel Commission include nickel only, while in other cases they include nickel plus cobalt. International Nickel Co. metal contains about 0.4 per cent cobalt, which is usually included in the copper analysis.

(Table I) except manganese varies from 2 to 5 per cent. This is used principally for spark plug wire to resist the action of high temperatures and combustion gases.

Table I gives the results of a number of chemical analyses of samples of commercial nickel, including that of foreign manufacture.

Besides the commercial forms of nickel described above, the metal is on the market in the form of anodes for the metal-plating industry. These cast anodes are quite variable in composition and contain from 88 to 95 per cent nickel together with iron, aluminum, tin, silicon, sulphur, and carbon. A typical analysis of a commercial anode is the following:

Graphitic carbon	1.70	Copper	0.15
Silicon	0.50	Aluminum	0.03
Iron	0.80	Nickel	96.82

USES OF NICKEL

The principal commercial application of nickel is in the manufacture of nickel steel, and this industry absorbed fully 75 per cent of the total nickel production during the war and probably 65 per cent normally. Nickel steels will be discussed briefly later.

Besides its use in steel nickel is used quite extensively as an alloying element with non-ferrous metals, principally copper; many of these alloys will be discussed in more detail. About 15 per cent of the production is utilized in the manufacture of alloys of nickel, such as cupro-nickel and especially nickel silver, the former series of alloys having come into prominence during the war. Nickel coinage and the electroplating industries may each absorb from 3 to 5 per cent of the production, the latter requiring the metal both in the metallic form and in the form of nickel salts; the single salts $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$ and the double salt $\text{NiSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$.

The production of malleable nickel, although never relatively large, has amounted to about 5 per cent of the total production and is steadily growing in volume as the properties of the metal in this form because better known. Malleable nickel is produced in all commercial forms and is used principally for coinage, cooking utensils (chiefly abroad in Germany and Austria) and other ornamental and household stampings and fittings. In the form of wire it is much used for motor ignition spark plug points, for the suspension wires in electric light bulbs, for electrical resistance pyrometers, electrical instruments, and recently in the construction of the audion amplifier.

Some malleable nickel is produced in the form of castings for apparatus such as digesters and evaporators for the chemical industry, for which its resistance to corrosion in sulphuric and other acids make it peculiarly suitable.

The Edison storage cell contains nickel both in the form of nickel oxide and as nickel anodes. Finely divided nickel is much used as a catalytic agent in the hydrogenation or hardening of oils, following the discovery of this property by Sabatier and Senderens. Nickel oxide is used in the ceramic industries for the production of under- or holding-coats of enamel on steel and also for coloring glazes on pottery.

Nickel castings have been used with much success as rabble shoes by the International Nickel Co., in calcining furnaces roasting nickel matte. The shoes are exposed to oxidizing and to sulphurizing gases at temperature from 600 to 1,000 deg. C. and to severe mechan-

ical abrasion; they have stood up in this severe service for nine months, whereas iron shoes would last no more than from six to eight weeks.

CASTING PRACTICE

Nickel is cast from the furnace into open molds to produce blocks for remelting, into ingot molds after deoxidation with manganese and magnesium for the production of malleable nickel and into sand molds for nickel castings. It is also poured directly into water to form nickel shot.

For the production of castings, the metal in the form of blocks or shot may be remelted in crucibles or in an oil-fired or electric furnace with the addition of charcoal to reduce the oxide which is present and which is formed during remelting. When at the proper temperature, it is poured into a ladle and deoxidized in the same manner as for the production of malleable ingots and poured into molds. The chief difficulty in the remelting of nickel is in the proper adjustment of carbon and oxide content of the molten metal prior to deoxidation, and which is known as bringing the metal to pitch.

Platers' anodes are melted with carbon and may be poured at a much lower temperature than malleable nickel and do not require deoxidation of any kind; they are consequently much easier to handle in the foundry than low-carbon metal.

The molding of nickel castings follows the practice used for steel castings, generally speaking, an allowance of $\frac{1}{4}$ in. to the foot being made for shrinkage.

Other than the process of deoxidation, which is absolutely essential, the production of malleable nickel ingots requires no novel operations not known, for instance, in the steel industry. Deoxidized nickel solidifies without blowholes but with a pronounced pipe, which renders necessary the use of proper risers or hot-tops and properly designed molds.

ROLLING, FORGING, ANNEALING

In the hot-working of nickel, both the temperature and the condition of the heating flame should be subject to careful control. The temperature for preheating and rolling should be from 1,100 to 1,180 deg. C. Ingots should not be subjected to temperatures much in excess of this, as they then become somewhat hot-short. Below this temperature the metal may be too hard to roll satisfactorily. The flame used for heating should be as nearly neutral as possible and a low-sulphur fuel (oil) is essential for successful heating.

For hot-rolling bars and rods of the usual cross-sections, the same designs of rolls as are used for steel may be and are employed with success. Pure nickel and nickel alloys of high nickel content are very easily guide-marked when hot.

The remarks of the first paragraph above apply also to the forging of nickel. Nickel is much more successfully forged under the hammer than under a press; in fact, the metal has a pronounced tendency to crack under the slow action of the press, which may be due to the fact that the surface cools more readily than under the quick blows and short contact of the hammer.

In order to soften nickel which has been worked cold it must be heated to at least 750 deg. C., the minimum temperature of the annealing range, and allowed to remain in the furnace until thoroughly heated throughout. It may be cooled rapidly or slowly, as desired, as there is no alteration in the properties of the metal

produced by cooling after annealing. For the commercial annealing of nickel a temperature of 900 deg. C. should be used, as this will insure a more thorough and homogeneous anneal.

Price and Davidson¹ have studied the annealing of nickel of commercial pure grade (A) and their results are shown in the accompanying figure. The annealing range for the metal is from 600 to 800 deg. C.; commercially the metal is usually annealed at 900 deg. C.

Whenever possible the metal should be annealed in tight boxes to prevent the formation of oxide, and any oxide formed may be reduced by the creation of a reducing atmosphere in the box, either by the presence of a small amount of charcoal or by the admission of some reducing gas. When annealing is done in this manner no pickling is required and on account of the difficulty and expense pickling should be adopted only as a last resort.

If necessary, pickling may be accomplished by the use of sulphuric acid with some oxidizing agent, such as ferric sulphate or chromic acid, at a temperature around 60 to 70 deg. C., but it is a slow and tedious process.

WELDING AND SOLDERING

Nickel cannot be smith-welded owing to the formation of a coating of nickel oxide which cannot be fluxed and which prevents the adherence of the two surfaces to be welded. On the other hand, under a reducing atmosphere the metal may be welded, such as by the use of the oxy-acetylene torch, or by electric-resistance welding. It is by the latter process that nickel wire is welded to iron wire to form tips or points for spark plugs.

Under suitable reducing conditions nickel may be plastically welded to steel, and an interesting process, invented by Dr. Fleitman about thirty-five years ago, of producing nickel-coated steel sheets is based upon this possibility. A steel sheet bar, about $\frac{3}{4}$ in. thick, is cleaned and pickled and placed between two thinner plates of clean nickel. Around the whole is wrapped a thin steel sheet, which protects the nickel against oxidation and is dissolved off by later pickling. The compound sheet bar is heated in a reducing atmosphere and then rolled and crossrolled into a solid, compound sheet. Needless to say, the nickel coating so produced is thicker and more durable than electrolytically deposited metal.

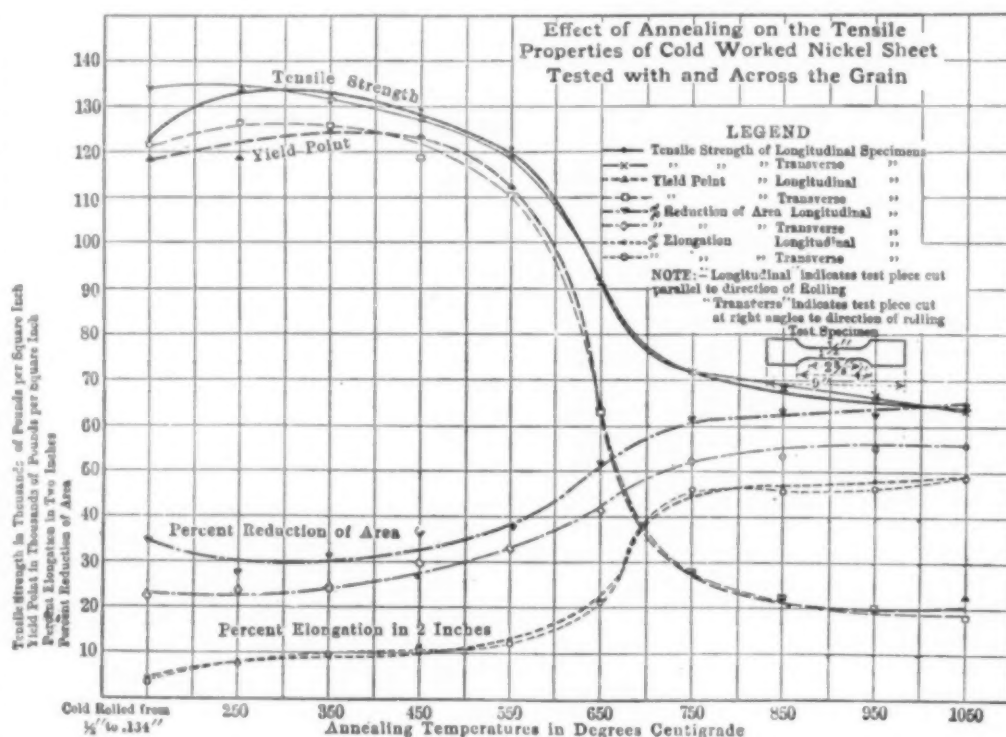
ELECTRODEPOSITION

Outside of the production of electrolytic nickel, the chief chemical application of nickel deposition is in the nickel plating of steel, brass, zinc and numerous alloys, generally in the form of castings or stampings, partly

for protection against corrosion but primarily for the improvement of appearance. Its chief value for this purpose lies in its relative hardness and its resistance to abrasion and atmospheric corrosion. Nickel is used to a limited extent in electrotyping, in which case it may be deposited directly upon the wax or lead mold, producing a true nickel electrotype; or it may be deposited upon the face of a finished copper plate, making a nickel plated electrotype. In general, the function of the nickel upon electrotypes is to give a harder wearing surface; which is also more resistant than copper to the action of the colored inks frequently employed. The production of nickel articles such as tubes by deposition upon wax or other fusible molds has never been commercially successful, though processes recently devised for this purpose appear promising.

PRINCIPAL SALTS OF NICKEL USED IN PLATING AND ELECTROTYPING

The principal salts of nickel used in plating and electrotyping are nickel sulphate and nickel ammonium sulphate (known commercially as "single" and "double" salts respectively). The nickel-ammonium sulphate has the advantage of better conductivity but the disadvantage of lower solubility. Mixtures of the two are frequently used. In 1878 Weston patented the use of boric acid in nickel baths, which has come into quite general use. Boric acid appears to favor more uniform



operation of the baths, and to produce brighter deposits. Experiments of L. D. Hammond² indicates that the essential function of boric acid is the maintenance of a uniformly small hydrogen-ion concentration in the solution. He found that good deposits can be obtained from solutions slightly acidified with strong or weak acids, none of which, however, is so suitable as boric acid for continued service.

Pure nickel exhibits in a marked degree the phenomenon of passivity when it is made the anode in most acids or salts. In consequence the use of pure nickel anodes

¹Discussion of paper by Browne & Thompson, *Transactions, A.I.M.E.*, 1919.

²"Electrodeposition of Nickel," *Trans., Am. Electrochem. Soc.*, vol. 30, p. 201 (1914).

in nickel sulphate solutions would soon bring about an impoverishment in nickel and the liberation of free sulphuric acid. It has hence been customary to add to nickel anodes appreciable amounts of iron, carbon and tin, which by local action increase the solution tension of the nickel. Incidentally they lower the fusing point, and thereby facilitate the casting of the nickel anodes, and contaminate the solution with an accumulation of slimes. This may be prevented to a large extent by the addition of chlorides, or more recently of fluorides, to nickel baths, both of which reduce anode passivity and increase the corrosion of purer metal. Chlorides of sodium, ammonium, nickel or magnesium are frequently added. The fluorine is usually added in the form of hydrofluoric acid, though it is preferable first to neutralize this acid with nickel carbonate, thus forming nickel fluoride.

In addition to aiding in anode corrosion, the presence of sodium or ammonium chloride increases the conductivity of the solutions. Other salts are sometimes added to nickel solutions to increase the conductivity—e.g., ammonium sulphate (in the form of or in addition to nickel ammonium sulphate) and magnesium sulphate. Salts of organic acids, such as tartrates, citrates, etc., which have also been added, may serve, (1) to regulate the acidity, (2) to dissolve basic compounds, especially of iron, and (3) to reduce the rate of chemical deposition of nickel by more positive metals. The latter function is especially useful in the nickel plating of zinc and zinc alloys.

In general, nickel plating has been conducted at low temperatures, but Watts' has shown that in solutions containing nickel chloride and sulphate, and boric acid, hot solutions may be employed to advantage, and may permit the use of much higher current densities.

FORMULAS OF VARIOUS TYPES OF NICKEL BATHS IN COMMERCIAL USE

The following formulas illustrate the various types of nickel baths in actual commercial use. It is not implied, however, that these formulas will always be satisfactory, much less that they are the best for a given class of work.

	Grams per Liter	Ounces per Gallon
<i>Nickel Electrotyping</i>		
Nickel ammonium sulphate...	45	6
Nickel sulphate	15	2
Sodium chloride	7.5	1
<i>Nickel Plating—Double Salt Solution</i>		
Nickel ammonium sulphate...	90	12
Ammonium chloride	22.5	3
Boric acid	15	2
<i>Nickel Plating—Single Salt Solution</i>		
Nickel sulphate	120	16
Ammonium chloride	22.5	3
Boric acid	15	2
<i>Nickel Plating (Watts)^a—For High Current Density, or in Hot Solutions</i>		
Nickel sulphate	240	32
Nickel chloride	15	2
Boric acid	30	4
<i>Nickel Plating on Zinc (Hammond)^b</i>		
Nickel sulphate	240	32
Nickel chloride	15	2
Boric acid	30	4
Sodium citrate	175	23

^aTrans., Am. Electrochem. Soc. vol. 29, p. 395 (1916) and vol. 23, p. 99 (1913).

^b"Electrodeposition of Nickel," Trans., Am. Electrochem. Soc., vol. 30, p. 201.

The Chemical Industry of Switzerland

BY DR. A. LANDOLL*

SWITZERLAND is exceedingly poor in raw materials and has to import practically everything (with but few exceptions) from abroad.

Switzerland's wealth of water power and the favorable position of the waterfalls made conditions somewhat easier for the chemical industry of the country after the problem of the transportation of electric power had been solved in the '80s and large power stations had been built on the Rhine, the Aar, the Doubs, the Rhone, etc. In particular a foundation was laid for electrochemistry and electrometallurgy which led to an enormous development, so that the condition of relatively cheap motor power could be fulfilled.

The second condition—namely, the existence of trained and skilled chemists, together with technical and commercial staffs—the chemical industry owes in the first instance to the high development of our federal and cantonal educational establishments, particularly the Federal University and Polytechnicum, and above all, the chemical institutions, which have always understood how to keep up an active and intimate contact between science and technics. All these factors have enabled the chemical industry of Switzerland to attain great prosperity in spite of the difficult circumstances in which it is placed.

The most important export branches of the Swiss chemical industry are the Basel aniline dye factories and the electrochemical and electrometallurgical works.

This comprises all the Swiss concerns which are occupied with the manufacture of artificial organic dyestuffs (aniline dyes) and the preparation of dyestuff extracts.

THE CHEMICAL-PHARMACEUTICAL INDUSTRY

Closely connected with the dyestuffs industry is the chemical-pharmaceutical industry, in which the Basel concern also participates. This branch made extraordinary progress during the war.

The chemical-pharmaceutical industry of Switzerland was established at a time when a number of chemical-pharmaceutical enterprises were already in existence abroad, especially in Germany. A great deal of courage and a keen spirit of enterprise were necessary in order to take up competition with the foreign industry, the reputation of which was already established. The plan thus tenaciously grasped and carried out with far-seeing vision prospered exceedingly, and today we may look with pride and happiness on the rapid and successful development of our native chemical-pharmaceutical industry. The factories were soon in a position to venture on independent labor in certain domains of pharmaceutical chemistry, and the preparations they have turned out have acquired a good name all over the world.

The export figure for pharmaceutical articles and drugs, which was 17,687,385 fr. in 1913, went up to 26,533,000 in 1919.

TAR DYES

The production of tar dyes increased from year to year and the Basel firms were keen competitors on the international markets. Since 1911 the Society for Chemical Industry, Basel, has taken up the manufacture

*President of the Swiss Society for Chemical Industry.

of artificial indigo and thus become a competitor of Germany. In order to be able to keep their place on the world's markets during the transition period and to compete successfully with Germany in future, the three leading Basel factories, the Society for Chemical Industry, the Chemical Works, formerly Sandoz, and the firm of J. R. Geigy, Ltd., formed an amalgamation in 1918 similar to that of the German factories, which provides for a community of interests for a period of fifty years. About 90 per cent of the total production of these firms goes abroad.

Founded in 1864 and transformed into a limited liability company in 1885, the Society of Chemical Industry at Basel now has a capital of 20,000,000 fr. and gives employment to more than 2,700 hands and 530 commercial and technical employees. Hence it occupies a not unimportant rank in the chemical industry of this country both as regards the manufacture of dyes and the preparation of pharmaceutical and photographic products.

During the last few years (from 1913 to 1919) the exports of aniline dyes went up from 25 to 123.6 million fr. The export value of artificial indigo rose in the same time from 3.9 to 12.2 million fr.

SYNTHETIC PERFUMERY

The synthetic perfumery industry was introduced into Switzerland in 1895, at first only on a small scale. The industry made rapid progress, however, and flowered in a comparatively short time. The six important firms which make these articles turn out natural perfumes by synthetic methods. The main business is done in exportation. The exports of perfumes and soaps totalled 16.1 million fr. in 1919.

The extension of the use of water power in Switzerland during the last two decades has contributed enormously to the development of the electrochemical and electrometallurgical industries. The oldest and at present the largest is the Aluminium Industry Co., Ltd., Neuhausen, with works on the Rhine Waterfall and at Chippis (established in 1888), which was the first in the world to produce pure electrolytic aluminum according to its own process. Nearly all electrochemical manufactures produced abroad are turned out in Switzerland too. The old methods based on chemical processes have been replaced by the electrolytic process, such as the manufacture of metallic sodium, caustic soda and chlorine, chloride of calcium, together with a number of other inorganic and organic derivatives of chlorine. We may further mention the manufacture of oxygen, hydrogen, nitric acid, hydrocyanic acid, nitrate of urea and their derivatives, then the persulphates, perchlorates, calcium metal, silicon, ferrosilicon, ferrochrome, etc.

EXPORTS

Thanks to the enormous demands on the part of foreign countries during the war for electrochemical and electrometallurgical products, the exports of these articles from Switzerland increased considerably, as may be seen from the following table:

	1913	1914	1915	1916	1917	1918	1919
	In 1,000 Tons						
Calcium carbide..	32	36	55	58	59	76	37
Ferro-alloys.....	16	17	19	23	23	16	10
Raw aluminum...	7	7	9	11	11	10	5
	55	60	83	92	93	102	52

The exports of these three articles reached their maximum in 1918, but they went down to almost half in

1919 after the demands of the belligerent countries had ceased. At the present time there are about eighteen electrochemical works in Switzerland. The manufacture of varnishes and paints, mineral and pigment dyes, printing and lithographing colors, glue, etc., has also taken a remarkably strong development.—*Swiss Exporter*, Special Edition for North America, p. 25.

The Removal of Nitrates by Means of Alcohol

BY R. SCHNEIDEWIND

Many analytic procedures demand the absence of nitrates. For instance, most methods for the electrolytic determination of nickel require that all nitric acid be expelled; in the determination of zinc in brasses, copper must be removed either by metallic aluminum or by sodium thiosulphate. Nitrates in the first case seriously affect the completeness of the separation; in the second case they oxidize the sulphur, hinder the copper precipitation, and if precipitation is completed there is a large quantity of colloidal sulphur that is very inconvenient to work with. In the separation of Zn and Al by means of H_2S in acid solution, in some electrolytic methods for determining Co, Fe, Cd and in many other cases nitrates must not be present.

Common practice is to add 10 to 15 c.c. of concentrated sulphuric acid and boil down until white fumes of SO_2 are evolved. This method gives rise to various objections. Considerable time is required to concentrate a solution of, say, 200 to 250 c.c.; there is always danger of bumping and spattering when a quantity of salts crystallize out; and as in the case of nickel, for instance, under some conditions complex sulphates are formed which are soluble only with difficulty.

The writer has used ethyl alcohol to remove nitrates in routine work—none remaining to interfere with any succeeding operation which would be incomplete in the presence of nitric acid. To a solution containing 20 c.c. concentrated HNO_3 and about 150 c.c. H_2O , 15 c.c. concentrated H_2SO_4 is added and then heated. When nearly boiling, 5 c.c. ethyl alcohol is added, taking care not to pour in too rapidly so that the solution boils over. From time to time 3 to 5 c.c. C_2H_5OH is cautiously added until further addition no longer causes an evolution of NO , fumes. It is then boiled five minutes longer to expel the excess alcohol. This will not give a positive test for nitrate with the usual brown ring reagent and does not oxidize the S in H_2S . The writer has found copper only to be affected when treated in this manner, some being precipitated as a cuprous compound.

About twenty minutes is required for the whole operation, including the time for boiling off the excess alcohol, thus effecting a great saving of time over the concentrating to SO_2 fumes method and without the danger of loss through spattering.

Laboratory, Studebaker Corp.

Sulphur Refinery to Be Erected in Portland

The Stauffer Chemical Co. has purchased a site in Portland, Ore., upon which to erect a plant for refining sulphur. Because of the increased railroad freight rates, great quantities of sulphur are moving from the Gulf of Mexico to Portland by the all-water route. Three full cargoes of crude sulphur in bulk have already been discharged at Portland for the Texas Gulf and Union Sulphur companies, and two more steamers have been booked to move sulphur cargoes from Sabine and Galveston, Tex., to Portland.

Survey of the Physics and Chemistry of Colloids*

Physical and Chemical Properties of the Colloidal Phase—Formation by Condensation and Dispersion—Symmetrical Structure—Resistance to Displacement in Solution—Viscosity and Colloidality—Aggregation and Other Structural Changes

By THEODORE SVEDBERG

THE science of colloids is a science of the micro-structure of matter. In it is reflected the tendency of modern natural science to deal more and more intensely with the problem of structure in its full extent. In the great science of the structure of matter, the science of colloids forms the domain that lies above molecular dimensions and beneath microscopic dimensions. In this domain we have a great number of those systems which are the basis of our material culture and the basis of life as a whole. All living beings are built up of colloids—almost all our food, our articles of clothing, our building materials, are colloids. Or, to mention some special systems, protoplasm, proteins, glue, starch, all kinds of fibers, wood, brick, mortar, cement, certain kinds of glass, rubber, celluloid, etc. The importance of colloid science for many industrial questions is, therefore, beyond all doubt.

The science of colloids is a rather young one. The field of study which it concerns has for a long time been disregarded. In order to be able to treat with success all the questions presented to us by industry, there is still much to be carried out in the department of pure colloid science. In what follows, I will try to give a short review of the scientific results so far obtained and of the problems which, in my opinion, need especial attention.

The various branches of colloid science are connected to such an extent that it is very difficult to treat the different questions separately. We will try to fix our attention on two principal problems: (1) The formation of colloids, and (2) the changes of structure in colloid systems. Connected with both these is the problem of the properties of colloids and the changes in these properties during the processes mentioned under problem 2.

The formation of a colloid may be effected in two ways, different in principle—viz., by condensation and by dispersion, according as one tries to obtain a micro-structural system, a colloid, from a molecular structural or a macrostructural system.

FORMATION BY CONDENSATION

In the case of a condensation process, the degree of "graininess" or the degree of dispersion will become higher as the degree of supersaturation increases, which must, of course, always precede condensation. This is the case when fogs are formed by adiabatic expansion of gases—e.g., cloud-formation in the atmosphere—when metal colloids are prepared by condensation of the vapors of metals from the electric arc, or when a slightly soluble substance—e.g., barium sulphate—is precipitated by means of a reaction between ions. The condensation

always proceeds from certain heterogeneities in the medium's condensation centers or nuclei. As such nuclei, we may have particles of the substance which is to be formed by the condensation—e.g., precipitation of gold on small gold particles when preparing gold hydro-sols or gold ruby glass—or gas ions—e.g., fog formations in cases at low degrees of supersaturation—or complex molecules—e.g., fog formations in gases at high degrees of supersaturation. The manner in which these nuclei are introduced into the system under condensation is of great importance for the degree of dispersion of the colloid resultant. If the nuclei are not introduced into the system all at once, but gradually in the course of the condensation process, the particles will be very unequal in size.

The biologically important colloids—e.g., the proteins—are evidently all formed by condensation, but no details of this process are known. The tendency toward condensation manifests itself in the fact that even the protein molecules are, from a purely chemical point of view, condensation products.

FORMATION BY DISPERSION

In case of a dispersion process, there is always work to be performed against the surface tension or the cohesion force. Accordingly, such a process is, in contradistinction to a condensation process, a forced and not a spontaneous one. We know very little as to the relation between degree of dispersion and experimental conditions. When emulsifying fats and hydrocarbons, the surface tension may be lowered by the addition of small quantities of alkalis or soaps. Grinding, in general, does not lead to a very high degree of subdivision; but it is possible to increase the latter by adding an indifferent solid diluent which can easily be dissolved and removed, leaving the disperse phase suspended in the solvent used. Thus, colloid sulphur has been prepared by grinding sulphur with urea and putting the substance in water. A combination of grinding and chemical effects on the material may also be used. It seems that, in many cases, a prevention of the aggregation of the particles by means of suitable additions ought to render possible the preparation of high disperse systems by pure grinding.

Bubbles and foam might be regarded as a kind of colloids formed by dispersion. On spontaneously breaking up they form new disperse systems in which the phase that was previously the continuous one becomes the non-continuous one, and *vice versa*. The system "soap foam—air," with the soap solution as the continuous and the air as the non-continuous phase, is transferred on account of surface reduction—i.e., condensation—into the system "soap solution drops—air," with the air as the continuous phase. Mercury foam

*Read before the Faraday Society and the Physical Society, London, Oct. 25, 1920.

in water (produced by means of pumping water through mercury) breaks up into a mercury hydrosol partly very fine-grained.

CHANGES IN STRUCTURE

A newly-formed colloid may, immediately after its formation, undergo changes of structure of a more or less profound nature. On the other hand, it is nearly always possible to prevent the occurrence of such changes and therefore we have a right to distinguish and investigate the primary structure as the direct result of the colloid-forming process. Colloids with primary structure may conveniently be called primary colloids.

We have at our disposal several methods for the closer study of the structure. Almost every property of a colloid depends on the structure, and therefore, conversely, from the study of the properties of colloids we may draw conclusions as to their structure.

The most important and most obvious means is the microscope and the ultramicroscope. With their aid it is often possible to settle whether the colloid under investigation is of a grainy structure—e.g., a colloid gold solution in water—a gold hydrosol, or of a foamy structure—e.g., high disperse soap foam—or of a fibrous structure—e.g., soap solutions of a certain concentration. The number and approximate size of the discontinuities—e.g., the particles—may also be determined in this way. One may, for instance, count in the ultramicroscope the number of particles observed in a certain volume of gold hydrosol, and by means of analysis determine the content of gold present in the sol. From these figures we get the mass and approximate size if, for instance, we make the assumption that they are spherical. On the other hand, the ultramicroscope gives little or no information about the form or structure of the particles.

SYMMETRY

A means of deciding whether the particles are symmetrical is to be found in the study of the behavior of the colloids in magnetic or electric fields. Non-symmetrical particles are oriented by such fields and thereby impart to the colloid a certain, though in general very slight, degree of double refraction, which may easily be measured with great accuracy. In this way we have been able to settle that the particles in common sulphur hydrosols, prepared by oxidation of hydrogen sulphide, are spherical; but sulphur hydrosols, prepared by grinding sulphur with urea, are dissymmetrical. The particles in gold hydrosols prepared by reduction are dissymmetrical to a high degree.

OPTICAL PROPERTIES

Two other optical properties, viz., the light absorption and its accompanying phenomena, the scattering and polarization of light—the Tyndall phenomenon—may also in certain cases be used for structure studies. Theory, as well as practice, proves that these phenomena are, for instance, dependent to a great extent on the degree of dispersion of the sol. The form and structure of the particles also influence the said properties, but in a manner hitherto unknown. The emission of light from illuminated particles especially—the Tyndall light cone—varies to a great extent with the size of the particles or the degree of dispersion. Colloid solutions that contain very small particles—e.g., Faraday's gold hydrosol—give only a slight emission; the light cone is scarcely visible. Those with large particles—e.g., gold

sols made from Faraday's gold sols by allowing the particles to grow in a reduction-mixture—emit very much light; the Tyndall cone is very prominent. The optical properties of the particles also play a great part. Thus metal particles emit much light, particles of silicic acid or of gelatine only a little.

RESISTANCE TO DISPLACEMENT IN SOLUTION

The resistance exerted on the particles by the surrounding medium when they move under the influence of a force is a means of investigation that is now often used for the determination of the size of the particles. In some cases—e.g., when a sol is filtered through a membrane of collodion or gelatine (ultrafiltration)—the connection between the resistance and the size of the particles is not known in detail, but we are justified in assuming that the resistance rises with the size of particles. The small particles are more rapidly pressed through the filter than the large ones. Certain kinds of filters transmit molecularly dissolved substances, but not colloids; an important method of separation, especially in biochemistry. If a colloid is separated from a great quantity of dispersion medium by such a membrane, the molecularly dissolved substances—the crystalloids—diffuse through the membrane, leaving a colloid of a purer state—Graham's dialysis. If the particles are spherical and move through a liquid, the resistance is $6\pi\eta rv$, where η is the viscosity, r the radius and v the velocity. If the force that causes the movement is known—e.g., gravity—the radius may be calculated.

Thus, by measuring the velocity of sedimentation, the radius can be found. We have

$$r = \sqrt{\frac{9\eta v}{2(s_1 - s_2)g}}$$

where s_1 is the specific gravity of the particle, s_2 that of the liquid, and g the gravity constant.

Even when no exterior forces are acting, the particles in a colloid solution are in movement because of the impacts from the surrounding molecules. This is the so-called Brownian movement, which has attracted so much attention of late. According to the kinetic theory of the Brownian movement, which has been fully confirmed experimentally, each particle, whatever its size and nature, has the same translatory energy as a mole-

cule—i.e., $\frac{3RT}{2N}$, where R is the gas constant, T the

absolute temperature, and N the Avogadro constant. Because of the resistance of the surrounding medium, the mean value of the quadrate of the distance traversed in the time t by the particle is $2Dt$, where D , the dif-

fusion constant of the particles, has the value $\frac{RT}{N} \cdot \frac{1}{6\pi\eta r}$.

Thus, if the displacement of the particle is measured the radius may be found. In certain cases it is more convenient to measure D directly and then calculate r by means of this experimental value.

Owing to the fact that the size of the particles is rather great in comparison with that of the molecules, colloids diffuse very slowly compared with crystalloids. As a matter of fact, Graham, the founder of colloid chemistry, regarded this property as the fundamental difference between colloids and crystalloids. We know now that between colloids and crystalloids—so very different in their extremes—there exist all degrees of transition forms and therefore all degrees of diffusibility.

The size of particles may also be determined by measuring the sedimentation equilibrium—i.e., the distribution of the number of particles per c.c. under the joint influence of gravity and the Brownian movement. In this equilibrium, the concentration of the colloid diminishes, exponentially with increasing height, as is the case with the atmosphere surrounding the earth.

Hence

$$r = \sqrt{\frac{RT}{N} \cdot \frac{\ln \frac{n_1}{n_2}}{\frac{4}{3} \pi (s_1 - s_2) g (x_2 - x_1)}}$$

The osmotic pressure of a colloid solution is determined, as far as the colloid in it is concerned, only by the number of particles per cubic centimeter (n).

We have

$$p = \frac{RT}{N} \cdot n$$

Consequently, the osmotic pressure is a measure of the degree of dispersion. The osmotic pressure of a colloid is often determined by means of a common osmometer, provided with a membrane permeable to crystalloids, but impermeable to the colloid particles. Now, however, owing to ion absorption, the particles are, in most cases, surrounded by an electric double-layer of ions, and the colloid thus acts as an electrolyte, one ion of which is able to penetrate the membrane, but not the other. This causes complications. A so-called membrane equilibrium is formed, and the osmotic pressure found is not a real measure of the structure of the colloid.

Owing to the Brownian movement, the number of particles in every small volume of a sol undergoes spontaneous and incessant fluctuations. Hence the value of every property of the colloid in the small volume fluctuates.

This phenomenon, predicted by the kinetic theory for colloidal as well as for molecular solutions, has been the subject of extensive investigations. The results are of importance because they show that Boyle's law holds good very exactly for dilute colloid solutions, and because of the light they have thrown on the applicability of the probability calculus to a natural phenomenon. From these studies we have also obtained a deeper comprehension of the conception of entropy. For they have shown, in a direct and experimental way, that the law of the incessant growth of entropy only holds for macroscopic systems.

It often occurs that the particles of a colloid are too small to be measured directly—e.g., by means of the ultramicroscope or by determining the velocity of sedimentation. In some of these cases one can overcome the difficulty by depositing gold on the particles, thus increasing their size. This method has already been applied to sols of almost all the metals, and to sols of some sulphides. If the quantity of gold on a particle is known, it is easy to calculate the radius in the usual manner.

In most colloid solutions and precipitates there are particles of various sizes, and the investigator should, of course, be able to determine not only the mean size, but also the real structure of the sol—e.g., the law governing the distribution of the various sizes of particles.

Finally, we will consider two phenomena, the study of which does not, it is true, enable us to carry out direct measurements of the structure, but which, in spite

of that, are of great interest in judging of the structure of colloids, viz., the viscosity on the one hand, and, on the other, the adsorption and the accompanying phenomena, viz., the cataphoresis and the electric endosmose.

RELATION OF VISCOSITY TO COLLOIDALITY

The viscosity of a sol depends, in a manner not yet known, on the size of the particles, the concentration, etc., but above all on the nature of the particles. Some sols—e.g., metal hydrosol, suspensions of barium sulphate (case 1)—have a viscosity only slightly greater than that of water, but others—e.g., silicic acid hydrosol, oil emulsion gelatine solution (case 2)—have a viscosity many times greater than that of water. From the fact that suspensions with undoubtedly solid particles come under case 1, and emulsions with undoubtedly fluid particles come under case 2, the conclusion has been drawn that the fine-grained colloids under case 1 also contain solid particles and those under case 2 fluid ones. If this be the case, measurements of the viscosity would be a capital means of ascertaining the state of aggregation of the substance of the particles. Recent investigations indicate, however, that the case is far more complicated. Small particles probably have relatively thicker water coverings than greater particles, and, accordingly, the viscosity is higher in a fine-grained colloid than in a coarser one, provided the two sols have particles of the same material and are of the same concentration by weight (e.g., sulphur hydrosols). When the potential difference between particles and fluid is altered the thickness of the water-coverings should alter and, as a matter of fact, the viscosity is altered too. As the water-covering increases, the particle will act more and more like a drop of fluid in relation to the surrounding medium and will, therefore, as far as the viscosity is concerned, approach more and more to the limiting case which is represented by an oil emulsion.

ADSORPTION

The phases—two or more in number—in a disperse system have a contact surface very largely relative to the volume of the system. It is obvious that in such circumstances, adsorption differs in strength. If an electrolytically-dissociated salt is adsorbed, cations and anions are, of course, brought together at the contact surface in equal numbers, but the adsorption of the particles in relation to cations and anions is most often unequal, inasmuch as one is present in excess nearest to the surface of contact and the other in excess some way out of the liquid. The result is the formation of an electrical potential difference, a so-called adsorption potential difference or an electrical double-layer. Because of this the disperse phase, when exposed to the influence of an electric field, will migrate toward one of the poles, provided it is freely movable, as in the case of a colloid solution (cataphoresis). If the disperse phase is immovable the liquid will move in the opposite direction (electrical endosmose). By measuring the velocity of migration of the particles or the liquid under various conditions we are able to study the changes in the difference of potential and thereby in the adsorption. At least at low concentrations the adsorption may be expressed by the formula

$$y = \alpha \cdot e^{\beta}$$

where y is the amount of substance adsorbed per grain adsorbent, e the concentration in the solution of the substance adsorbed, and α and β constants depending

on the nature of both. Now, as a rule, it happens that for the two ions of a salt both α and β have different values—e.g.,

$$\alpha \text{ cation} < \alpha \text{ anion}$$

$$\beta \text{ cation} > \beta \text{ anion}$$

In the example chosen the disperse phase will with increasing adsorption become more and more negative in relation to the dispersion medium. This charge reaches a maximum and decreases to zero, at the point where the adsorption isotherms intersect, then becomes positive and increases again.

COLLOIDAL TRANSITION

The changes of state which may occur on a disperse system, a colloid, are essentially changes of structure. Of course, purely chemical reactions, too, are to be taken into consideration, but they do not play such a prominent part here as in the molecular structural systems. The greater number of the disperse systems, and those of greatest importance, too, are the ones whose disperse phase is embedded in the other phase in the form of particles; in the sequel we will only mention the changes of state in such systems. The most important change of state is the uniting together of the single particles (primary particles) into aggregates (secondary particles). Such an aggregation often occurs directly after the formation of the particles. It may stop for various reasons after the aggregates have reached a certain size. The result is a colloid with complex particles—a secondary colloid. If the aggregation goes on further we may have two extreme possibilities—with many transition forms.

FACTORS DOMINATING IN COLLOIDAL TRANSITION

First Case.—One or more of the following factors dominate—viz., (1) low hydration of the particles; (2) low number of particles per unit volume; (3) great difference in specific gravity between particles and liquid; (4) violent stirring of the system.

The characteristic of this case is that no bridges are formed between the aggregates and that, in consequence of this, they fall to the bottom after having grown sufficiently; the colloid is precipitated (e.g., coagulation of a gold hydrosol by the addition of hydrochloric acid).

Second Case.—One or more of the following factors dominate—viz., (1) high hydration of the particles; (2) high number of particles per unit volume; (3) small difference in specific gravity between particles and liquid; (4) no stirring of the system.

In this case bridges are formed between the aggregates, and the particles arrange themselves into a three-dimensional network throughout the system; the colloid gelatinizes (e.g., the coagulation of a sol of silicic acid by the addition of hydrochloric acid, the setting of a warm gelatine solution when cooling). Owing to capillary forces the liquid is kept in the network with great strength. Measurements have shown that the liquid is under a pressure of several hundred atmospheres. In many respects, therefore, the gelatinized colloid acts as a solid.

NUMEROUS TRANSITION FORMS BETWEEN THE EXTREME CASES

There exist numerous transition forms between these two extreme cases. If the particles are not bound together by bridges into a solid, but still reach macroscopical size and possess a certain loose structure, one

speaks of flocculation of the colloid (e.g., coagulation of ferric hydroxide by addition of ammonia). It may be doubted, however, if such flocculent suspensions are not to be regarded as fragments of a gel of little mechanical resistance shattered by the stirring of the liquid. In case 1 the Brownian movements alone of the particles should suffice.

CAUSE OF AGGREGATION

The most important cause of the aggregation of the particles is the decrease or the disappearance of the difference of potential between particle and liquid. This may be effected by altering the ion adsorption. Hence one of the most important means of bringing about aggregation or disaggregation is addition or removal of ions. Because of the opposite electric and coagulating action of anion and cation and their difference of adsorption there will always exist, for certain electrolytes in relation to a certain colloid, a domain of concentration within which they have a disaggregating action. If a solely aggregating electrolyte is added to a colloid in increasing doses (e.g., hydrochloric acid to a gold hydrosol), the velocity of aggregation first rises rapidly with concentration, then more slowly and reaches a constant maximum value. Let us make the assumption that within the latter region every mutual approach of two particles to a certain limit leads to aggregation, but within the former region only a certain fraction of those approaches. Then it is possible to develop, on the basis of the laws of the Brownian movements alone, a mathematical theory for the kinetic of aggregation.

With regard to the aggregation by electrolytes it has, in addition, been found that inorganic ions of the same valency generally aggregate equally strongly if added in equivalent amounts. This is due to some extent to their being nearly equally strongly adsorbed. When the valency of the aggregating ion increases, the aggregating effect rises very rapidly. The concentrations of the ions K^+ , Ba^{++} , Al^{+++} required to aggregate particles of As_2S_3 to the same degree show the mutual relations: 1, 1/20, 1/1000. Thus the three-valent Al^{+++} has an aggregating power 1,000 times greater than the monovalent K^+ . These circumstances are closely related to the course of the adsorption isotherm, but are not yet quite clear.

The aggregation may be reversible or irreversible—i.e., in certain cases disaggregation may be effected—in others not. Some colloids (e.g., metal hydrosols) are difficult to disaggregate, others (e.g., sulphur hydrosols) are easy. Certain ions nearly always bring about irreversible, others reversible aggregation. The question of irreversible or reversible coagulation is probably closely connected with that of the hydration of the particles. Thus particles which hold much water around them are easily disaggregated. The water-covering prevents the particles from uniting too closely together.

PROTECTIVE COLLOIDS

The aggregating effect of an electrolyte may often be reduced to a very great extent by the addition of a small quantity of a suitable colloid of another kind only slightly sensitive to electrolytes, a so-called protective colloid—e.g., gelatine to a gold hydrosol. As a rule the electric charge of the protective colloid should be of the same sign as that of the colloid to be protected. The mechanism of this protecting action is still but very incompletely known. Most probably the particles of the protective colloid become attached to the particles

of the other colloid and the aggregate resulting from this obtains a good deal of the stability toward electrolyte which characterizes the protective colloid. Colloids of opposite electric charge precipitate each other mutually (e.g., the negative Sb_2S_3 and the positive Fe_2O_3) provided there is not too great an excess of either of them, in which case no precipitation will occur. This is obviously entirely analogous to the action of the ions. Such mutual colloidal reactions are of great importance in the economy of nature and in industry.

In the preparation of easily aggregated colloids a protective colloid is often added in order to maintain the primary structure. Thus the particles of a metal hydrosol, if formed in the presence of a small quantity of a protective colloid, are kept apart even when the sol is evaporated to dryness. The dry substance can be redissolved in water without any perceptible change of structure taking place (e.g., commercial colloid silver).

OTHER STRUCTURE CHANGES

A change of structure that plays a part, formerly a little over-rated, in colloid solutions with comparatively easily soluble particles is the growth of the larger particles at the expense of the smaller ones. In a suspension of calcium sulphate this change of structure is clearly visible, but in the more sparingly soluble barium sulphate the process goes on at an extremely slow rate. Formerly, aggregation, especially the irreversible process, was often interpreted as a recrystallization. In irreversible aggregates as well as in compressed powders there gradually take place association and crystallization phenomena which may greatly change the structure of the system (e.g., silver crystals in sediments from silver colloids).

Processes of the latter kind play a prominent part, especially in gelatinized colloids. On the whole, a great variety of changes in structure and accompanying processes may occur in gels. When gradually deprived of water the gel of silicic acid, for instance, goes through a series of states, some of which differ rather decidedly from others. The nature of these processes is not yet known. A gelatine gel probably consists of particles with a high percentage of "dry substance," and a liquid with a low percentage. In sol-formation water is supposed to pass over from the liquid to the particles, the particle-associations being thereby disintegrated; in the gel-formation the particles lose water.

The study of the structure of gels is a rather difficult one. The particles of most gels do not contrast optically to any great extent with the surrounding medium, and consequently the ultramicroscope is not able, as a rule, to make their primary particles visible. Moreover, these are often packed together so closely that they cannot be distinguished from one another optically. On the other hand, we have been able to study with more success the macroscopic properties of the gels in chemical and physical respects. The elastic gels, especially gelatine, collodion, celluloid, rubber, etc., play a prominent part in industry, and their investigation is, therefore, a matter of great importance.

University of Upsala, Sweden.

Leather Industry Establishes Research Laboratory

Under the auspices of the Tanners' Council of the United States the American Leather Research Laboratories will be established at the University of Cincinnati. G. D. McLaughlin will be in charge.

Legal Notes

BY WELLINGTON GUSTIN

Vessel of Paper United by Fused Cement Not Patentable

The United States Circuit Court of Appeals at Detroit has held that the Harbeck patent, No. 1,062,002, claim 1, for a vessel having walls made of layers of paper united to each other by a fused cement, was void for anticipation, the claim of invention being old in the art at the time Harbeck claimed he made the discovery.

The claim of the patent was on the use of a fused cement to unite sheets of paper into duplex board, practically impervious to moisture, grease and aroma. The court found that the use of fused cement for the purpose of uniting sheets of paper into duplex board was old in the art, having been used for similar purposes and known commercially for more than two years prior to the date Harbeck's application for patent was filed, and therefore the use of this material by a can company in the manufacture of its cans was not invention, but a matter of mechanical skill and judgment.

Salesmanager of Chemical Company May Not Alter Contract of Company Without Authority

A new trial has been awarded by the Court of Errors and Appeals of New Jersey to the Interstate Chemical Co. in its action against the James Leo Co. The chemical company brought this suit to recover for breach of contract, in writing, by which the seller, the James Leo Co., agreed to deliver 10,000 folding boxes, as per sample submitted. The buyer, the chemical company, claimed that by reason of the failure of the seller to deliver the boxes, as per the order, it was obliged to go elsewhere in the public market to purchase the boxes at a far greater price than that fixed in the contract, and that it sustained a further loss by reason of the failure of the seller to carry out its contract and make delivery of the boxes.

The seller claimed a set-off for the value of the labor performed and materials furnished in and about the boxes, and charged that the contract had been modified by the buyer agreeing to take boxes in one color instead of two, and that the buyer had refused to accept the boxes under the modified contract.

Upon trial judgment was given for the seller on its counterclaim, and the Supreme Court of New Jersey affirmed this judgment. On appeal to the Court of Errors and Appeals the first question presented was whether the salesmanager of the chemical company had any authority to alter the terms of a written contract made by his principal, the chemical company. The court said there was no attempt to prove he was so expressly authorized, and that the mere fact of his being the salesmanager gave him no such authority.

The second question was whether the salesmanager was held out by the chemical company as authorized to make this change in the original contract. Now the rule is that where one holds out another as his agent one is bound the same as if express authority has been given. It did not appear that the salesmanager had ever before attempted to change any original contract for the company.

Again it was urged that the chemical company had by its actions subsequently ratified the contract as modified by its salesmanager. The court found that it had no knowledge of the change in the contract until an attempt was made by the James Leo Co. to deliver the boxes all in one color. Ratification by principal of acts of an agent implies that the principal had knowledge of the facts and acquiesced in them.

Court Holds Seller Under the Contract Could Have Others Manufacture the Products

The Court of Errors and Appeals of New Jersey has affirmed the judgment in the action brought by the National Metal Stamping & Manufacturing Co. against the Associated Rolling Mills, Ltd., appealed from the Supreme Court.

The action arose out of a sales contract. The rolling mills contended that at the time of the execution of the agreement it was not in the contemplation of the parties that the National company would have the products called for made by other manufacturers and thus obtain the advantage of their cheaper method. And because nothing on this question appeared in the contract the rolling mills contended that the company was bound to manufacture the articles itself, though it might cost more than they were to receive from the buyer.

The court comments that the buyer must have been extraordinarily ignorant of human nature if it did not in fact contemplate that the seller would seek the cheapest possible way of fulfilling its contract. And if it did not contemplate such when the contract was made, the court said that it must be held bound under the law to contemplate that the seller would pursue the course usual with prudent business men.

United States Supreme Court Holds Virginia Tax Unconstitutional

The United States Supreme Court has reversed the judgment obtained by the State of Virginia against the F. S. Royster Guano Co. of Norfolk. The latter operates a fertilizer plant in Norfolk County, Va., and several plants in other states. During 1916, the company made net profits from the operation of its plant in Virginia amounting in round figures to \$260,000; and from its plants in other states the net profits were about \$270,000. Under the revenue law of the state the guano company returned for taxation as income the former amount, omitting the latter. Under appropriate provisions of the state law, the state officials added the latter amount, and assessed an income tax against the company upon the total.

The company then asked the court at Norfolk for relief from the tax on the \$270,000 for the reason that the state law, in taxing that part of its business which was transacted outside of the limits of Virginia, imposed upon it a burden not placed upon domestic corporations doing no part of their business in Virginia but transacting business beyond the limits thereof, such corporations being expressly exempted from a tax on income derived from business done without the state limits; the state laws thus denying to the company the equal protection of the laws, in violation of the Fourteenth Amendment of the U. S. Constitution.

The court at Norfolk sustained the tax law and this judgment was affirmed by the Virginia Supreme Court of Appeals. The guano company then appealed to the Supreme Court of the United States. This court has said the imposition of tax on income from sources out-

side the state is invalid, where corporations doing no business within the state are not taxed. It says the Virginia law (Acts Va. 1916, ch. 472) in so far as it imposes on a domestic corporation doing business both within and outside the state a tax with respect to its income derived from sources outside the state, denied such corporation the equal protection of the laws, in violation of the Fourteenth Amendment, in view of the statute (Acts Va. 1916, ch. 495) exempting domestic corporations doing no part of their business within the state from any tax on their income; the classification of the property taxed not being reasonable, but arbitrary, not resting upon any ground of difference having a fair and substantial relation to the object of the legislation, so that all persons similarly circumstanced shall be treated alike.

While the latitude of discretion is wide in the classification of property for purposes of taxation, a discriminatory tax cannot be sustained against the complaint of a party aggrieved, if the classification is altogether illusory, said the court.

Manufacturer Must Account for Royalties

An appeal from an order to render an accounting by the Belmont Packing & Rubber Co., formerly known as the Clement Restein Co., unto Norman B. Miller has been dismissed in the Supreme Court of Pennsylvania. It appears that Miller sued the company and recovered a verdict, upon which the order for an accounting was entered, and the appeal was taken.

Plaintiff alleged that he contracted orally with the corporation by which the latter was to pay him 3c. a lb. on all "piston rod packings manufactured and sold by defendant" under certain patent rights which plaintiff had assigned to it, until the expiration of such patents; that the assignments were made, first, for a square hole piston rod packing, and next, for a round hole piston rod, relying upon the oral promise of payment in royalties; that large quantities of the patent article have been sold by the company without an accounting for the royalties due.

The company admitted the assignment of the patent rights, but denied having made any oral or written promise to pay compensation therefor. Mr. Restein, president of the company, testified that both he and Miller worked on the inventions "for the benefit of the company," but it appeared that Miller was the inventor of the patented articles. The rule of law as stated is that one who accepts and continues to take and retain the benefits of an agreement cannot be heard to deny the authority of the agent who acted for him in making the agreement. Restein was thus held to have authority to make the royalty contract as alleged, and the company receiving the benefits from the assignment is liable for the royalties, and the obligation to pay the royalty subsisted so long as the company continued to sell the articles.

In the absence of a contractual stipulation to the contrary, the obligation to pay the royalty would continue, and, after a reasonable time, on demand, the company would be bound to account to the inventor for the sales made by it, the reasonableness of the time being a question to be determined by court or jury.

The assignment contract mentions the sum of \$1 as the consideration for the assignment of the patents, but the court held that such did not prevent the inventor or assignor from showing the real consideration for the patent rights.

Engineering Problems in Dust Explosion Prevention

Causes and Factors Affecting Dust Explosions — Types of Industrial Plants Affected — Ignition Temperatures — Propagation and Velocity of Flame — Pressures Developed — Relation of Humidity — Prevention

BY DAVID J. PRICE*

AT THE present time the prevention of dust explosions is commanding the earnest attention of engineers of all classes both in the United States and abroad. This is quite natural, since many engineering problems have been developed in the study of dust explosions, their causes and prevention. Before these explosions can be prevented, it is necessary to understand fully their nature and behavior. This means a determination of the various causes and circumstances under which dusts may be ignited; the manner in which the explosion spreads or propagates; the ignition temperature of the various dusts; the pressure that will be developed during the explosion, and also the effectiveness of any methods which may be designed for prevention.

It is not the intention to consider in this article the simple causes that have been established since the study of grain dust explosions was undertaken by the Federal Government. It is well known that disastrous explosions have resulted from the ignition of flammable dusts by matches, open flames, lanterns or torches. The attention of engineers at the present time should rather be directed particularly to the mechanical causes, especially those which occur during the handling of organic materials.

TYPES OF INDUSTRIAL PLANTS

In order to understand the nature and extent of dust explosions it is essential that consideration be given to the kind of industrial plants in which these explosions are occurring.¹ Dust explosions have occurred most frequently in plants where grain or grain products are either milled or handled, such as grain elevators, flour mills, feed and cereal mills and starch factories. Disastrous explosions have occurred also in sugar refineries, cocoa and chocolate plants, candy factories, spice works, wood-working establishments, paper mills and printing plants, shoe factories, fertilizer works, cork-grinding plants, drug and herb works and similar types of industrial plants where dusts are created. Explosions of aluminum and magnesium dusts have also taken place. Many disastrous smut and grain dust explosions have occurred in threshing machines in the Pacific Northwest, while a large number of fires have also occurred in cotton gins during the ginning process.

Since May, 1919, a series of very disastrous explo-

sions have occurred in the United States and Canada, resulting in the death of over eighty-eight persons, injury to a large number, and property damage in excess of \$7,000,000. Three of these explosions have occurred in grain elevators, one in a feed mill, one in a starch factory and two in flour mills. In the starch factory explosion forty-three lives were lost and over \$3,000,000 damage was done. Fourteen lives were lost in one grain elevator explosion and ten in another, both explosions being very violent and doing extensive damage to property. In an explosion of "aluminum dust" in a North-western factory six girls lost their lives and as many others were injured. A recent explosion of "hard rubber" dust in a Michigan plant resulted in the death of eight workmen and has attracted considerable attention.

IGNITION TEMPERATURES OF GASES AND DUSTS

From the experimental work which has already been conducted it appears that a dust explosion is very similar to a gas explosion. Although particles in a dust cloud are larger than the minute molecules in a gas mixture, yet the nature and behavior of a dust explosion appears to be very much the same as a gas explosion. To produce a gas explosion it is necessary that a proper mixture of gas and air and a source of ignition be present. The same condition exists in connection with producing a dust explosion. It is as impossible to produce a "spontaneous" explosion with dust as it is with gas. In both cases the explosive mixture must be ignited by some external source of heat or flame.

In order to obtain some idea as to the relation between dust explosions and gas explosions it will be of interest to note the ignition temperatures of the more common flammable gases in air as determined by Dixon and Coward.²

Gas	Ignition Temperature Deg. C.
Carbon monoxide.....	644 to 658
Hydrogen.....	580 to 590
Ethylene.....	542 to 547
Methane.....	650 to 750
Ethane.....	520 to 630

A series of experiments was conducted by R. V. Wheeler, chemist attached to the Explosions in Coal Mines Committee of England. In the first series of tests an effort was made to determine the temperature at which the dust would ignite and propagate flame. A second series of tests was conducted to determine the lowest temperature at which ignition could be effected. The following results were obtained:

Kind of Dust	Ignition Temperature, Deg. C.	Temperature of Flame Propagation, Deg.
Dextrine.....	540	940
Sugar.....	540	805
Starch.....	640	960 to 1035
Flour.....	650	1060
Grain.....	630	995 to 1050

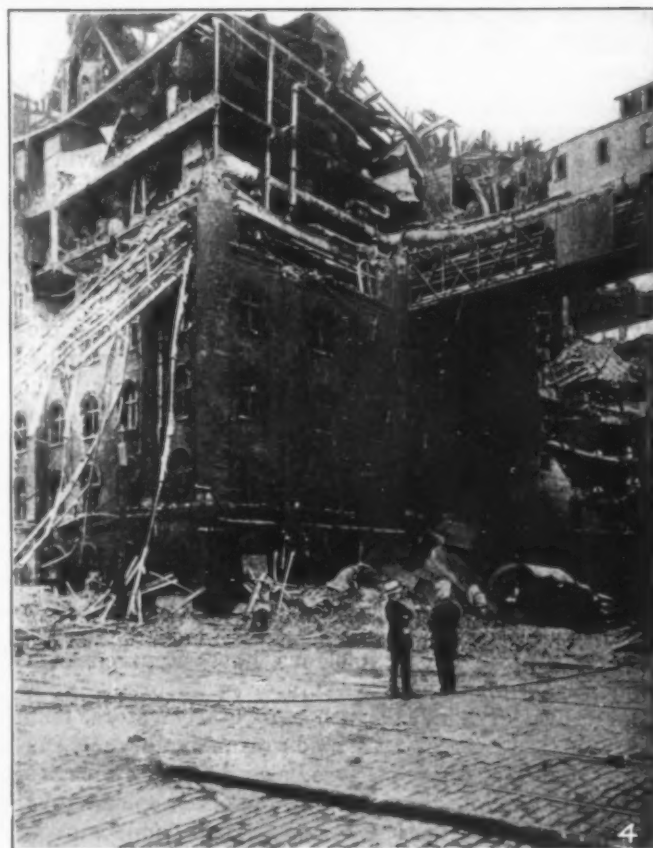
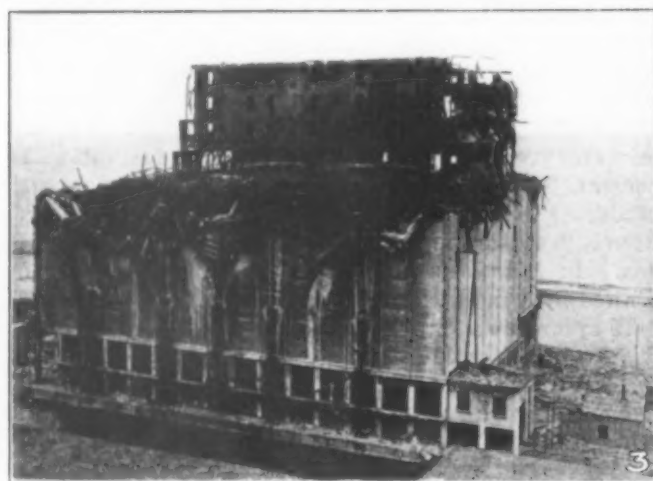
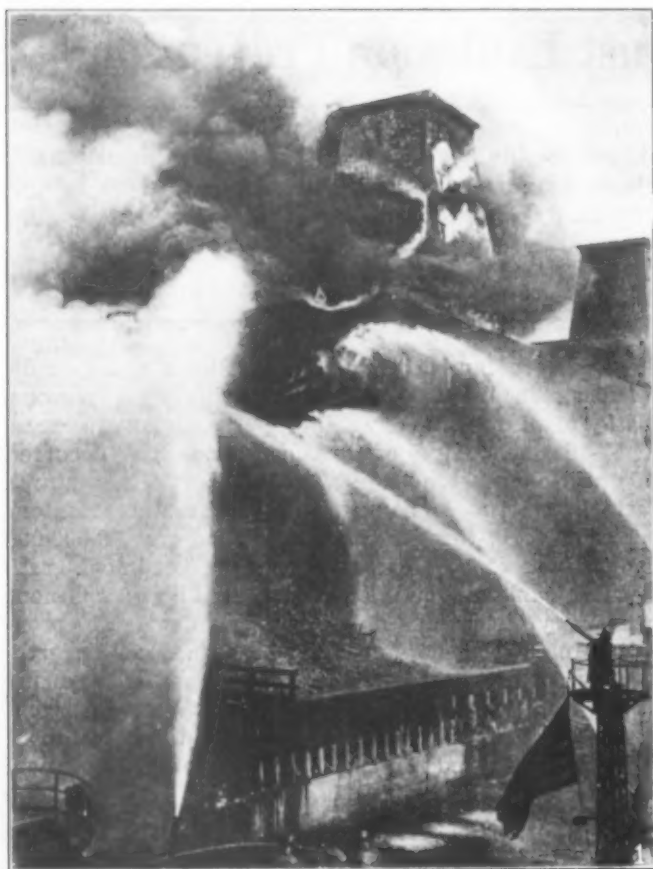
*Engineer in charge Grain Dust Explosion Investigations, Bureau of Chemistry, U. S. Department of Agriculture, Washington, D. C.

¹The National Fire Protection Association, the National Safety Council and similar organizations are now using the word "flammable" instead of the old word "inflammable." Some persons have misinterpreted inflammable, thinking of the first two letters of this word as the prefix in whose meaning is not, as in inactive (not active), or incombustible (not combustible). Flammable is shorter, more definite and cannot be misunderstood. The negative of flammable is non-flammable.

²The study of the cause and prevention of coal dust explosions is being undertaken by the Bureau of Mines, United States Department of Interior, while the work pertaining to the cause and prevention of dust explosions in industrial plants is being carried on in the Bureau of Chemistry of the Department of Agriculture.

³CHEM. & MET. ENG., vol. 23, No. 19, Nov. 10, 1920, p. 915.

⁴Trans. Chem. Soc., vol. 95, p. 517.



TYPICAL INDUSTRIAL CONFLAGRATIONS

Fig. 1. A large grain elevator in New York harbor being destroyed by fire following dust explosion. Sufficient grain was lost to supply bread rations for 200,000 men for one year.

Fig. 3. Grain elevator, Port Colborne, Canada, at entrance to Welland Canal, badly damaged by grain dust explosion, resulting in loss of ten lives.

Fig. 2. A starch factory in Iowa completely destroyed by starch dust explosion. Forty-three lives were lost and \$3,000,000 property damage was done.

Fig. 4. A sugar refinery badly damaged by explosion of sugar dust. Twelve lives were lost and sugar stocks were destroyed.

Wheeler states in his report that sugar and dextrine appeared to be the most flammable of all the dusts, the temperature at which ignition could be effected being 540 deg. C., a temperature well below red heat. It is interesting to contrast this low temperature with the ignition temperatures of the gases given above, from which it will be noted that the ignition temperatures of sugar and dextrine are lower than methane, carbon monoxide and hydrogen, ranging with ethane and ethylene. Most of the remaining dusts have practically the same ignition temperature, 600 to 650 deg., thereby ranging with the other gases.

When the Federal Government began the study of dust explosions attention was directed to a determination

of the ignition temperatures of the various dusts and the methods and conditions under which these dusts propagated flame. With the apparatus used in the tests, the following results were obtained:⁵

Kind of Dust	Ignition Temperature Resulting in Propagation
Wheat elevator dust.....	1295 C. equals 2363 F
Flour.....	1265 C. equals 2300 F
Oat and corn elevator dust.....	995 C. equals 1821 F
Oat hull dust.....	1020 C. equals 1868 F
Yellow corn dust.....	1025 C. equals 1877 F

⁵Preliminary Report on the Explosibility of Grain Dusts. Co-operative Investigation by Millers Committee, Buffalo, N. Y., under the direction of Dr. George A. Hulett, chief chemist, Bureau of Mines, U. S. Department of the Interior, by David J. Price, engineer in charge, and Harold H. Brown, assistant chemist, Grain-Dust Explosion Investigations, Bureau of Chemistry, U. S. Department of Agriculture. Copies no longer obtainable.

From the many theories which have been advanced in the effort to explain the action that takes place during the progress of dust explosions, two appear prominently: (1) That a distillation of flammable gases occurs when the dust becomes heated, resulting in an explosion; and (2) that the explosion is nothing more than a rapid communication of flame or fire from one particle to another, depending to a large degree on the fineness of the dust. That is, the finer the dust and the lower the moisture content the more rapid the propagation and therefore the greater the violence accompanying the explosion. This would seem to establish very definitely a relation between fire and explosion.

In connection with the investigation of a large number of explosions and fires in grain threshing machines in the Pacific Northwest, the Department investigators made the following determinations:⁶ In 117 cases observed 95, or about 80 per cent, were sudden, violent explosions, and the remaining 22, or 20 per cent, were merely fires. This would seem to indicate that in the majority of cases the explosions were accompanied by violence, while in the others the fire had not advanced to a point where it assumed the proportion of an explosion.

In the 95 cases referred to it was felt that the explosion might be classified either as sudden and violent, or as slight and muffled in nature. The same phenomenon has developed in connection with dust explosions in industrial plants. In many cases a primary explosion, which is nothing more than a small puff, is followed by fire in which the property is extensively damaged or destroyed. In other cases a series of explosions follows, becoming more violent as it progresses, destroying both life and property. This would seem to indicate very definitely that if the dust is present in the plant to feed the original flame, an explosion follows. In plants where little dust is in suspension and where "good housekeeping" is practiced, the occurrence merely assumes the proportions of a fire and no violent explosion results. Reference is made to this phenomenon at this time to emphasize the fact that a disastrous dust explosion may occur during the course of any fire if sufficient combustible dust is present in the plant to feed the flame and allow it to propagate. The dust that accumulates throughout the plant is thrown into suspension by slight concussion, with the result that the primary "ignition" or explosion develops into a secondary explosion of large proportions.

VELOCITY OF FLAME

Experimental work has been conducted to determine the velocity or rate of flame travel in dust explosions. It is understood that the rate of propagation or flame travel in a gas explosion depends upon two factors: (1) The flammability of the gas, and (2) the amount of gas present. For instance, the explosive limit of methane gas ranges from 5½ to 14.5 per cent,⁷ with 9.6 per cent as the most flammable mixture. With this latter percentage the rate of flame travel is the most rapid and the explosion most violent. The rate of flame travel in dust explosions depends also on (1) the flammability of the dust, and (2) the amount of dust in suspension. In some of the early reports of the Bureau of Mines it is stated that the average velocity of flame in coal dust explosions is 2,270 ft. per second. British investigators

report 2,114 ft. per second, while in French experiments 3,300 ft. per second has been obtained.

The maximum velocity of propagation of flame in many gaseous mixtures has been determined with accuracy. The following results have been obtained:

Gaseous Mixtures	Velocity, Feet per Second
Hydrogen, $2H_2 + O_2$	9,250
Ethane, $C_2H_6 + 3O_2$	7,724
Methane, $CH_4 + 2O_2$	7,616
Carbon monoxide, $2CO + O_2$	5,510

The velocity of propagation in explosions through most gas mixtures is more rapid than through most dust clouds, although in a few cases it has been found that the velocity of flame propagation in coal dust explosions has exceeded the maximum for certain gases. In only two tests has any attempt been made to measure the velocity of propagation of the flame in clouds of materials other than coal dust. One indicated that the velocity through a cloud of wheat flour dust was practically the same as through coal dust; the other that the propagation through a cloud of powdered starch was several times as rapid as through coal dust. The results, however, cannot be considered to be conclusive.

PRESSURES DEVELOPED BY DUST EXPLOSIONS

In connection with the determination of the ignition temperatures and the relative ease of flame propagation of dusts an effort has been made to determine the pressures developed during the progress of the explosion. In the large-scale tests that have been conducted the Bureau of Mines reports a pressure of 103 lb. per sq.in. with coal dust. British investigators report pressures ranging from 100 to 120 lb. per sq.in. Taffanel, a French investigator, reports pressures of 227 to 270 lb. per sq.in. He states that in one test at the steel gallery an established pressure strength of 227 to 270 lb. per sq.in. was maintained and that pieces of steel were thrown up a distance of 150 m., or 472 ft.

Much work to determine the relative flammability of the various dusts has been done by both the Bureau of Mines and the Bureau of Chemistry. After a series of extensive experiments the following results, based on the use of 75 mg. of dust in the standard laboratory apparatus, were obtained:⁸

Kind of Dust	Pressure Generated Lb. per Sq. In.
Lycopodium.....	17.5
Wheat smut dust.....	15.9
Yellow corn.....	15.2
Dextrine.....	14.6
Tanbark.....	13.3
Wheat elevator dust.....	13.0
Wood dust.....	12.8
Corn starch.....	12.7
Sugar.....	12.2
Potato flour.....	11.7
Fertilizer.....	10.5
Coal (Pittsburgh).....	10.1
Cocoa.....	9.1
Sulphur.....	8.8
Cork.....	7.4

From these results it might be concluded that the grain dusts are more flammable than Pittsburgh standard coal dust. This has been confirmed by large-scale tests which indicate that flame propagates through a cloud of grain dust more easily and with a more violent explosion than through a corresponding amount of coal dust.

In very recent tests conducted in co-operation with the Bureau of Mines in the steel galleries at Bruceton, Pa., it was found that flour and coal dusts acted similarly. Starch dust propagated more rapidly, produced

⁶U. S. Department of Agriculture, Bulletin 379, p. 5.

⁷U. S. Bureau of Mines Technical Paper 150, p. 6.

⁸Journal of Industrial and Engineering Chemistry, vol. 9, No. 3, p. 269.

higher pressures, and did a great deal of damage to the steel galleries used in the tests.

It has already been stated that dust must be present in suspension in proper proportions before an explosion can occur. Efforts are being made in the experimental work to establish these proportions, as has already been done in connection with the gas mixtures. In some of the tests conducted results were obtained when one-twentieth grain, or 0.00176 oz., of dust was put in suspension in 1,400 c.c., or 85.36 cu.in., of air. To obtain the same proportion of dust in air and render the mixture as flammable as that used in the laboratory test it would be necessary to have only 10 lb. of the dust in a closed room containing 4,466 cu.ft., or a room 10 x 30 x 15 ft.

The first dust explosion to attract attention in this country occurred at Minneapolis in 1878. Professors Peck and Peckham of the University of Minnesota conducted experimental work in the investigation which followed the explosion. In this investigation it was found that by blowing 2 oz. of dust upon an open flame in a box containing 2 cu.ft. of air sufficient pressure was developed to lift two men standing on the cover.* This would mean diffusion at the rate of 1 oz. of dust to 1 cu.ft. of air space. Their report states that a sack of flour and 4,000 cu.ft. of air will generate force enough to throw 2,500 tons 100 ft. high.

The Bureau of Mines reports that explosions could be produced when only 0.032 oz. of coal dust was suspended in 1 cu.ft. of air, or 1 lb. in 500 cu.ft. It was found in order to produce complete combustion all the oxygen in 1 cu.ft. of air was required to burn 0.123 oz. of the dust used.

In the French experiments conducted by Taffanel an instance is cited when the low weight of 0.023 oz. of dust per cu.ft. of space was sufficient to produce an ignition.

Experimental work is now in progress to determine definitely the smallest amount of dust in suspension per unit area through which an explosion can propagate.

RELATION OF HUMIDITY TO EXPLOSION FREQUENCY

The relation of humidity to the frequency of dust explosions has been markedly noticeable in the investigational work. This is especially true in connection with explosions where static electricity has appeared as a probable cause. In the large number of thresher explosions in the Pacific Northwest, which comprises the inter-mountain territory between the Cascade and Rocky Mountain ranges, it was found that in 128 cases 86 explosions, or 70 per cent of the total, occurred between the hours of 1 and 7 p.m., when the humidity was extremely low. The range of humidity was usually from 6 to 17 per cent. These explosions have occurred in grain separators during the threshing of wheat containing smut dust. In 112 explosions from 1 to 35 per cent of the heads of wheat being threshed were smutted. In 108 cases the average smut percentage was 15.

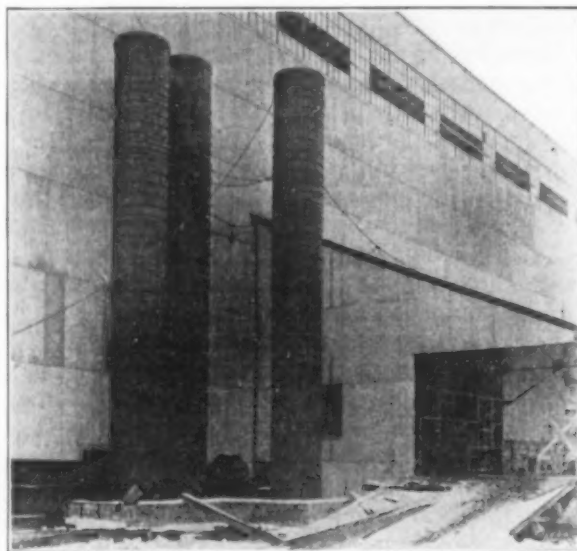
A study of fires in cotton gins in certain sections of the South developed the same relation. Although this relation has not been definitely determined in industrial plants it is reasonable to conclude that the dust explosion hazard is greater during periods of continued low humidity.

This article has been confined largely to the theory of dust explosions together with the causes and factors

affecting these explosions. An article is now in the course of preparation dealing with the methods of prevention that have been developed and proved effective, and also the chemical engineering research problems demanding attention.

Wood Pipe in the Chemical Industry

The accompanying illustration shows a system of towers for the collection of hydrofluoric acid from acid phosphate manufacture at the plant of the Jarecki Chemical Co., Cincinnati. This pipe was manufactured and installed by the Michigan Pipe Co., of Bay City, Mich. The layout is composed of three vertical towers of 48-in. inside diameter, the acid gas



WOODEN TOWERS FOR HYDROFLUORIC ACID

main being 30 in. inside diameter and the special wood elbows and tees also constructed of 30-in. pipe. The gases are drawn from the bottom of tower 1 to the top of tower 2 through a 32-in. specially mortised pipe connection. Draft is created by the exhaustor at the bottom of tower 2. This type of construction is becoming general in the fertilizer industry and pipe may be made in any lengths desired up to 16 ft., being constructed of 3-in. thick Canadian white pine staves, double-tongued and grooved on the lateral edges and molded on the inner and outer faces to conform with the inside and outside diameter of the pipe. Each section of pipe is mortised and tenoned so that it may easily be set in place. The towers are tightened by the $\frac{3}{4}$ -in. rod placed 10 in. apart, excepting at the joints, where the spacing is 4 in. to provide extra strengthening.

Glare vs. Light Diffusion in Industrial Lighting

All large industrial organizations know the necessity of coating the interior of their plants with a white finish of some type to obtain improved light distribution, lower power bills and maximum efficiency from their employees. To accomplish this it has been the custom to paint the walls and ceilings of the plants with a Gloss Mill White. This was soon found, however, to be unsatisfactory, as the shiny surfaces acted as so many mirrors reflecting the light in a glaring manner and causing eye strain to develop among the employees. The Sherwin-Williams Co. spent years

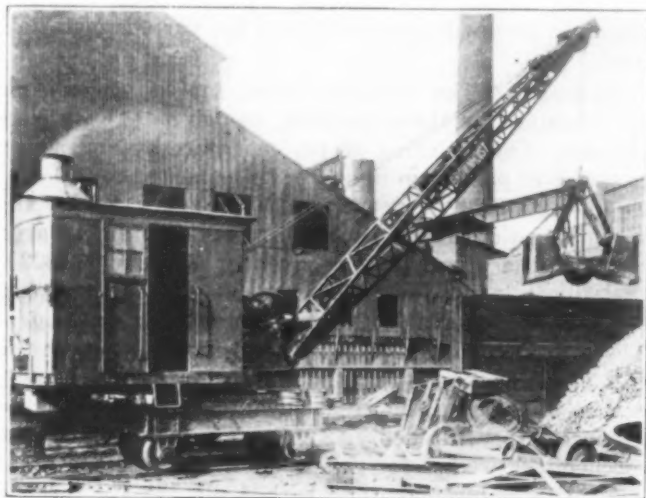
*Chemical Engineer, March, April, May, 1908.

in research and consulted with some of the leading authorities on illuminating engineering and industrial plant maintenance in an effort to overcome this difficulty. The research work was not confined to reflection values alone, but much time and money were spent in getting the proper combination of pigments and vehicle to produce the desired results. Special mixtures were necessary to get just the right finish, wearing qualities and minimum absorption. As a result the exact point between the two extremes of Gloss Mill White and Flat Matte surface was determined to give the most efficient light distribution and a new paint product known as Eggshell Mill White was evolved. This product, instead of reflecting the light, disperses and diffuses it uniformly throughout the plant, thus emitting a soft, pleasant light restful to the eyes instead of the irritating glare of the high gloss surface. Another advantage of this new product is the fact that less coats are required to give the same results, thereby reducing costs for time, labor and material.

Small Type Locomotive Crane for Industrial Use

Many of the larger companies during the past few years have found it economical to handle a large part of their materials by locomotive crane. This has been necessary because of the large tonnage handled and because the crane is so much more economical than hand labor. Up to the present time, however, most of these cranes were large-capacity machines and too big to be economical in some of the smaller plants.

The saving effected by cranes at these larger plants has created a demand for a smaller type which can be used economically where there are not so many or so



SMALL TYPE OF STEAM LOCOMOTIVE CRANE EQUIPPED WITH GRAB BUCKET

heavy loads to be handled. With the idea of filling the need for a smaller capacity high-grade crane for this work, a new Brownhoist locomotive crane has just been placed on the market by the Brown Hoisting Machinery Co. of Cleveland. This machine can be changed in a few minutes' time to handle grab bucket, bottom block or magnet. With these attachments almost all kinds of materials can be handled.

Experience with the larger type locomotive cranes has proved them to be well fitted to handle ore, coal, crushed stone, etc., by bucket. With bottom block

all kinds of sling loads are handled. With magnet the cranes handle pigs, scrap, bars or castings. This new crane will do the same work as the larger types within its capacity. It is built to handle a 1-yd. bucket, hook loads of five tons, or a 36-in. magnet.

In order to meet the different working conditions, these new Brownhoists are made to operate by steam, electricity or gasoline engine. They are built for use on railroad trucks, traction wheels or creeper trucks.

Synopsis of Recent Chemical & Metallurgical Literature

Electric Purification of Fumes and Gases.—A lengthy description of the Electric Purification of Fumes and Gases is given by A. DELASALLE in the September, 1920, issue of *Chimie et Industrie*.^{*} The theory of electric purification is summarized: When a very small spherical particle of radius r suspended in a gas of viscosity a and possessing an electric charge e is placed in an electric field of intensity H , this particle will be displaced in the direction of the field with a velocity which depends on the intensity of the field and the mobility of the particle in the gas, and whose value, according to the author, is given by $V = KH$ in which K is the coefficient of mobility.

Prof. Pascal conducted a series of experiments to determine the values of K for the case of sulphuric acid particles. The tests were made with electrodes of smooth wire and with asbestos thread covered wire so as to increase the emissive power of the electrodes.

He found that K varies with the temperature as shown in the following table:

Temp. Deg. C.	Value of K
24	2.4×10^{-4}
32	4.9×10^{-4}
52	13.6×10^{-4}
55	15.1×10^{-4}

He also found the values of the radius r of the droplets as being between 0.8×10^{-4} and 5.5×10^{-4} cm. The conclusions reached are:

The gradient of a convenient potential corresponding to the point where the intensity begins to increase rapidly is in the neighborhood of 4,000 volts per cm.

The phenomenon is independent of the wave frequency; at least the result was the same for frequencies between fifteen and forty-five periods per second.

The separation of the acid in the fumes is especially a function of the wave amplitude.

Asbestos-covered electrodes do not present any advantages, especially with liquid particles, due to the fact that the humidity soon nullifies the effect of the downy surface.

It is advantageous to have the emissive electrodes of very small radius of curvature and the receptive electrodes of high radius curvature and as smooth as possible.

The use of chambers of masonry is to be avoided in treating fumes containing acid droplets.

After describing the apparatus used for the produc-

^{*}"L'Épuration électrique des fumées et des Gaz dans le service des poudres pendant la guerre," A. Delasalle, *Chimie et Industrie*, September, 1920, pp. 291-316.

tion of rectified current and the Gaillard precipitator, the author outlines the calculations of an appropriate sized apparatus and how he applies these calculations mathematically and graphically to compare the action of tubes of different diameter. He arrived at the conclusion that there is no great advantage in using very high potentials and cites the fact that even in America where potential differences as high as 250,000 volts are employed, in treating sulphuric acid fumes not over 70,000 is used. (War time conditions in France limited the experimentation voltage to about 42,000 volts.)

Tests were also made to determine the influence of the radius of curvature of the emissive electrode, and it was found that the precipitation increases gradually when the radius of curvature of the axial electrode decreases.

A series of tests on the influence of the tension and polarity of electrodes with tubes of varying diameter are also described and tabulated. The reinforcement of the intensity of the field for a given tension by approaching the electrodes has also been studied so as to verify certain points of the Badische Anilin- and Soda-Fabrik and G. A. Krause patents.

Tests were made with precipitation tubes having electrodes of small diameter (30/10 mm.) at the entrance of the gas and then 80 mm. tube concentric in one of 200 mm.

The reinforcing of the axial electrode was obtained by a cylinder having a rounded form at both extremities sliding on the 30/10 wire. This arrangement was decided upon in order to determine the length giving the maximum of precipitation and to find out whether it was possible to diminish the length of the receiving tube.

With a receiving tube of 3 m., 42,000 volts and with the same velocity of the gases the results obtained are shown in the following table:

Length of the Wire 30/10 mm.	Length of 80 mm. Cylinder Concentric to the 200 mm. Cylinder	Visual Percentage of Precipitation
3.0	0.00	90
2.7	0.30	95
2.5	0.50	97
2.0	1.00	95
1.0	2.00	90
0.5	2.50	80

Tests with stoneware receiving cylinders were made with a 150 mm. diameter tube constituted of five sections each of which was 0.65 m. high gave the following qualitative results:

Efficacious Rectified Potential Volts	High Tension Intensity Amperes	Approximate Velocity of the Gas Meters per Second	Visual Per- centage of Precipitation
28,200	4.5×10^{-3}	4.6	55
29,200	4.5×10^{-3}	3.0	85
32,200	4.5×10^{-3}	3	90

The apparatus used for the experimentation and their modifications are fully described and illustrated, and the results of fifteen general tests tabulated. The author then describes the research work as applied to the purification of the sulphurous gases in roasting pyrites, giving the apparatus used, the testing conditions and the tabulated results. He concludes with the statement that the coefficient of mobility of the dust is about 40×10^{-4} at 230 deg. C. and 57×10^{-4} at 310 deg. C. with a negative electrode of 20/10 mm., and that it is absolutely necessary to have the gases at a temperature as high as possible.

Purification of Acetone.—It is known that acetone forms with carbon disulphide a mixture whose boiling point is about 39 deg. C., the boiling point of acetone being only 22 deg. C., and that the impurities in the acetone, with the exception of methylal and methanol, do not form such mixtures with carbon disulphide. J. DUCLAUX and A. LANZENBERG have used this property for the purification of acetone. (*Bulletin de la Société Chimique de France*, Oct. 5-20, 1920, pp. 779-782). The acetone to be purified is mixed with carbon disulphide in the proportion of 1 vol. acetone and 1.7 vol. CS_2 (by weight 1 acetone to 2.8 CS_2). The mixture is submitted to fractional distillation. The elimination of methylal is based on the property that the boiling point of the mixture methylal- CS_2 is 31 deg. C., whereas the boiling point of methylal is 42 deg. C. The fraction passing at about 31 deg. is the mixture methylal- CS_2 . The fraction passing between 38 and 40 deg. C. contains the mixture acetone- CS_2 and some methanol- CS_2 , as the boiling point of this last mixture is about 37.5 deg. C. The methanol is separated by treating the fraction with potassium carbonate. A compound, probably methyl-xanthogenate, is formed which when dissolved in water is precipitated by copper sulphate. A mixture containing 90 acetone and 10 methanol when thus treated gave a mixture containing only 4 methanol. By repeating the operation the separation of the methanol can be practically complete. The remaining pure acetone-carbon disulphide mixture is washed well with water to extract entirely the acetone. The wash water is rectified and the product obtained is practically pure acetone.

Contribution of Chemistry to Aeronautics.—The September, 1920, issue of *Chimie et Industrie* contains an excerpt of Prof. CHARLES MOUREU'S work on chemistry and the war, with reference to the contribution of chemistry to the aeronautic industry. The author passes in review the production of the various materials used. Thus:

Hydrogen. The hydrogen used for filling balloons was obtained by three methods, namely: (1) By electrolysis. The resulting 98 per cent pure hydrogen was passed over palladium in quartz tubes heated to 650 deg. C., giving a 99.97 per cent pure hydrogen. (2) By the action of silicon on alkaline solutions. Captain Lelarge has used the principle, first given by Berzelius (1823), that silicon is attacked by caustic soda or potash, giving the acid silicate $NaHSiO_3$ with liberation of hydrogen. The hydrogen he obtained was very pure. Although the cost of production by this method was higher than by electrolysis, it had the great advantage that it could be produced where needed. (3) By fermentation. In the biochemical process for the production of acetone great quantities of hydrogen and carbon dioxide are formed. The carbon dioxide is separated by liquefaction or absorbed by an alkaline solution and the remaining hydrogen is ready for use.

Helium. After passing in review the history of helium since its discovery during the sun eclipse in 1868, he describes the advantages it presents for filling balloons and the work done in the United States for the extraction of helium from natural gas. At present a French commission headed by Prof. Moureu is studying the thermal gases of Bourbon-Lancy, Maizières and Santenay, which contain respectively 2, 6 and 10 per cent helium.

Special Steels. The steel used in the construction of aeronautic machinery has to have special properties

which can be realized only by the help of chemistry and metallurgy. Among the special steels found is that of Colonel Grard, a self-hardening nickel-chrome steel of the composition of C 0.25-0.40, Mn 0.40-0.60, Si 0.20-0.30, Ni 3.5-5.00, Cr 1.2-2.00. He describes briefly the properties of this special steel as well as those of nickel steel, chrome steel, tungsten steel, silicon steel, manganese-siliceous steel and chrome-tungsten steel.

Aluminum and Its Alloys. France has the advantage of possessing bauxite mines located near hydro-electric plants so that aluminum can be produced practically cheaper than anywhere else. During the war the growth of the use of aluminum has been very marked. A number of aluminum alloys have been used to advantage to replace steel in the manufacture of different parts of machinery. The alloy most used was duralumin of the composition Al 93.9, Cu 3.70, Mn 0.61, Zn 0.25, Mg 0.43, Si 0.58, Fe 0.53.

Motor Fuels. Motor fuels presented many difficult problems, especially when it is considered that the quality of the fuel is of prime importance in the efficient working of the motors. The fuels used were grouped into two classes—namely, Asiatic and American. He describes their characteristics and the care taken to free them of sulphur compounds, acids and water and to lower the proportion of unsaturated hydrocarbons.

Lubricating Oils. Special lubricating oils being required for the motors, extensive chemical studies were made to obtain oils that maintain their lubricating properties even when submitted to the very great variations in temperature encountered in aeronautics. He mentions that shortly before the war Prof. Hemptine of Liège obtained lubricating oils of very high viscosity, called polymerols, by circulating slowly a mixture of a mineral oil with a semi-drying oil between the armatures of a high-tension condenser. This product was used advantageously to increase the viscosity of fluid mineral oils. During the war the Germans confiscated the plant and worked this process for their needs.

Non-Freezing Liquids for Cooling the Motors. The usual method of making the cooling water non-freezing by the addition of alcohol or glycerine was rendered difficult by the lack of these last products. Chemical work on this problem resulted in the adoption of sodium formate as proposed by Messrs. Simon and Darmois. The addition of 270 g. per liter lowers the freezing point to below -20°C . and the solution does not attack the metals used in the radiators. Calcium chloride, a waste byproduct of the Solvay soda process, can replace advantageously the sodium formate.

Dopes. Extensive work was done to manufacture dopes appropriate to the needs of the aeronautic industry. Practically all the dopes used by the French were of cellulose acetate base; the Allies made partial use of dopes with nitrocellulose as base. Tests proved that cellulose dopes are far better than glue, gelatine, albumin, casein, bakelite, algin, alkaline glycerosilicates and similar products. He passes in review the manufacture of cellulose acetate and outlines the work done to determine the appropriate mixtures used as solvents. For camouflaging dopes triacetin mixed with eugenol was utilized. Different colors were obtained by direct incorporation into the ordinary dopes of a mixture of aluminum powder, colored lakes and mineral matter.

Varnishes. Cellulose acetate being hygroscopic, the dried doped fabrics have to be varnished to protect them against atmospheric humidity. The two groups of

varnishes used were nitrocellulose varnishes and fat varnishes. Varnishes with synthetic resins as base have been developed but not used industrially. Inert or organic coloring matter was incorporated in the varnishes used for camouflaging.

Fabrics for Balloons. The material used in France was cotton fabric (seldom of silk) covered with rubber, generally two layers of cotton fabric alternating with rubber layers. Vulcanizing was done with sulphur chloride at 35°C . The problem of the influence of light on the fabrics had to be solved. The best solution found was the use in France of a lead chromate dye; Italy and Great Britain used dopes in which aluminum powder was incorporated. Tests were made to use rubber substitutes and by the end of the war France was experimenting with cotton fabrics treated with dopes having cellulose acetate as base. Even now the problem of a good material for balloons has not been solved. This problem deserves to be still further studied, especially when it is considered that helium, which is bound to become of general use for filling balloons, is too expensive a product to be wasted through the use of fabrics which are not sufficiently impermeable.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Synthetic Anthraquinone Derivative.—Anthraquinone derivatives such as alizarine may be made from phthalic anhydride by first preparing p-chlorbenzoyl-o-benzoic acid, and condensing this with concentrated sulphuric acid to form chloranthraquinone, from which alizarine may be made by treatment with caustic alkali in the presence of an oxidizing agent. JOHN M. WEISS of New York, GEORGE C. BAILEY of Woodcliff-on-Hudson, and RALPH S. POTTER of Grantwood, N. J., suggest the following method for making the chlorbenzoyl benzoic acid: A mixture of 100 parts of finely ground phthalic anhydride with 180 parts of coarse freshly sublimed aluminum chloride is added to 1,000 parts of chlorbenzene at 120°C . After a short time the temperature is reduced and water or ice is added prior to the introduction of 80 to 90 parts of 60 per cent H_2SO_4 . Excess chlorbenzene may now be removed by steam distillation. Crude chlorbenzoyl benzoic acid is filtered from the cooled mass, dried and washed. The addition of the proper amount of H_2SO_4 to the filtrate will give (upon concentration) about 230 parts of aluminum sulphate as a byproduct. (1,255,100; assigned to The Barrett Co.; Oct. 5, 1920.)

Zinc Oxide and Hydrogen.—By vaporizing carbon-free metallic zinc in a suitable retort and treating the zinc in the vapor phase with an excess of superheated steam RALPH H. MCKEE of New York is able to produce zinc oxide free from blue-powder, with hydrogen as a byproduct, according to the reaction:



The zinc oxide is recovered by cooling the reaction

product and filtering through bags. The steam:hydrogen mixture is then further cooled to condense the steam, leaving the hydrogen in a substantially pure state. (1,355,904; Oct. 19, 1920.)

Alloy for Chemical Apparatus.—An alloy of iron, molybdenum and chromium low in carbon and silicon is especially adapted to the manufacture of chemical apparatus, being sufficiently strong to resist accidental breakage and soft enough to permit being machined to shape. Iron may be replaced by cobalt or nickel; molybdenum by tungsten. Indeed, the very best alloy from the chemical standpoint is composed of nickel and tungsten, each of which is the most resistant chemically of the members of their respective groups, combined with enough chromium to constitute a mutual solvent, but the composition is comparatively expensive and somewhat more difficult to machine. Certain typical formulas are as follows, the proportions being by weight:

	A	B	C	D
Chromium.....	60	55	60	40-60
Iron group metal.....	20	25	30	10-40
Molybdenum-like metal.....	20	20	10	10-20
Carbon.....	Less than 1 per cent			
Silicon.....	Less than 1 per cent			

Column A gives the alloy that appears to be the most resistant chemically of any investigated. Columns B and C give the compositions which are most easily made when the iron group metal employed is iron. Column D indicates the limits of favorable composition. (1,357,550; FRANK A. FAHRENWALD, of Cleveland, Ohio; Nov. 2, 1920.)

Dicyandiamide as Stabilizer for Nitrocellulose.—The lower nitrates of cellulose, particularly pyroxylin soluble in ether-alcohol, may be stabilized by the addition of 0.1 to 2 per cent of dicyandiamide, $\text{NH}:\text{C}(\text{NH}_2)_2$. (1,358,653; CHARLES L. REESE, of Wilmington, Del., assignor, by mesne assignments, to the Arlington Co.; Nov. 9, 1920.)

Coking Process and Apparatus.—The Wallace oil-shale retort, which has been described in *CHEM. & MET. ENG.*, vol. 22, p. 809, April 28, 1920, may be used for the distillation of coal provided certain modifications are introduced. This retort is a vertical cylinder externally heated and provided with a central perforated eduction pipe through which the vapors are removed by suction. In treating coal, coke formation proceeds in vertical concentric rings from the wall toward the center. The passage of gases or vapors through the newly formed coke must be prevented, since this causes minute cracks which develop into fissures during the final shrinkage of the coke. Two methods for overcoming this difficulty are described. (1,358,663 and 1,358,664; GEORGE W. WALLACE, of East St. Louis, Ill.; Nov. 9, 1920.)

Diaphragm for Electrolytic Cells.—Mineral wool is mixed with paraffine oil as a binder and compressed to form an osmotic diaphragm—that is, one which not only allows the free passage of ions liberated during electrolysis but also permits the diffusion of liquids by osmosis. According to MILO W. KREJCI, of Chicago, and GUNNARD E. JOHNSON, of Hammond, Ind., such a diaphragm is particularly adapted for use in the electrolytic manufacture of white lead by the Harrington process (U. S. P. 1,308,948; July 8, 1919). In this process it is essential that CO_2 ions should pass from the catholyte to the anolyte at the same rate at which lead acetate

is formed in the anode compartment, so that the precipitate of white lead may be formed in the solution away from the anode and thus settle to the bottom without any danger of coating the anode. (1,358,858; Nov. 16, 1920.)

Chlorination Process.—Saturated hydrocarbons such as petroleum naphtha are treated counter-currently with chlorine in the absence of light, yielding a solution of chlorine in the hydrocarbon mixture, which is then passed through heated coils in which chlorination takes place. After cooling, the liquid is recirculated through the chlorine absorption tower and this cycle is repeated until the desired degree of chlorination is reached. Vapors which escape during chlorination are treated in condensers and absorption towers for the recovery of valuable constituents. (1,358,851; ARTHUR E. HOULEHAN, of Wilmington, Del., assignor to E. I. du Pont de Nemours & Co.; Nov. 16, 1920.)

Acetyl Chloride and Phosphorus Oxychloride.—Glacial acetic acid is mixed with phosphorus trichloride and the temperature maintained at about 10 deg. C. while sufficient cold, dry chlorine is introduced to complete the reaction:



The reaction products are easily separated by fractional distillation since acetyl chloride boils at about 51 deg. C. and phosphorus oxychloride at 106.5 deg. C. The still residue consists largely of phosphoric acid. (1,359,071; FREDERICK J. KAUFMANN, of Charleston, W. Va.; Nov. 16, 1920.)

Chloroform From Isopropyl Alcohol.—Isopropyl alcohol gives good yields of chloroform when distilled in the usual manner with chloride of lime and water. The isopropyl alcohol may be obtained by absorbing vapors rich in propylene in sulphuric acid, followed by hydrolysis of the propyl hydrogen sulphate to give isopropyl alcohol (see *CHEM. & MET. ENG.*, vol. 23, p. 1230; Dec. 22, 1920). (1,359,099; MAX PHILLIPS, of Evansville, Wis.; filed under the act of March 3, 1883; Nov. 16, 1920.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Treating Vegetable Fibers.—Vegetable fibers of all kinds and in any stage of manufacture are treated by fixing thereon the products of the hydrolysis of proteic substance to impart to the fibers the character of wool, both physically as to feel, appearance and calorific qualities, and chemically as regards their affinity and absorbent capacities for dyestuffs. The treatment of the fibers is also a preparation for the usual printing processes. The fibers, whether in the mass or in the state of lap, cops, card-ends, twistings, yarns or fabrics, are treated with the liquid obtained by the action of strong acids, alkalis or other hydrolyzing agents on proteic substances to which oxidizing agents may be added, and are then washed with water with, if desired, a preliminary washing with a dilute acid or alkali, or a saline solution. The fibers may finally be treated with formaldehyde, alone or with ammonia, or with phosphoric acid. In a modification of the process, the fibers are impregnated with a proteic solution, the deposit being treated, if desired, with formaldehyde and tannin. The fibers may then be dried and are subsequently treated with a hydrolyzing agent, with or without the addition of an oxidizing agent, and are finally washed with water, after the preliminary washing if desired. Casein, egg

albumin, serum albumen and gelatine are mentioned as suitable proteic substances, and nitric, sulphuric, hydrochloric, phosphoric and formic acids, zinc chloride and caustic soda are given as examples of suitable hydrolyzing agents. (Br. Pat. 150,665, not yet accepted; Soc. GILLET ET FILS, Lyon, France, Nov. 24, 1920.)

Pulverizing Metals.—Zinc or other metal is reduced to powder by heating the metal to the highest possible temperature it can attain without volatilization, and pouring it in a thin stream upon a steam jet issuing at high pressure in a horizontal direction from an orifice, elongated horizontally so as to give a flattened formation to the jet. A convenient form of apparatus comprises a small furnace with a melting pot for heating the metal and a chamber, inclosed except for a space in the top, beneath which an inch steam pipe, flattened at the end to an opening, $\frac{1}{8}$ in. deep, enters, and long enough to allow the jet to expand itself in traveling its length. The molten metal poured by a ladle on to the jet a short distance from the orifice is instantly disintegrated and blown along the chamber, and may subsequently be collected, dried and screened. (Br. Pat. 150,490—1919; J. P. MILLER, Uplands, Swansea, Nov. 17, 1920.)

Granular Calcium Cyanamide.—Granular calcium cyanamide is produced by treating calcium cyanamide with more than enough water to slake the lime, etc., under such conditions of temperature and pressure that the excess water is immediately evaporated. Temperatures of 70 to 80 deg. C. and a reduced pressure are mentioned. The water may contain dissolved or suspended matter which may enter into reaction with the calcium oxide or may have a binding effect. The substances mentioned are sodium sulphate, ferrous sulphate, clay, cyanamide and potato meal, and urea. Carbonic acid may be introduced with a salt solution and may serve to spray the solution over the cyanamide. (Br. Pat. 150,979, not yet accepted; AKT. GES. FÜR STICKS-TOFFDÜNGER, Knapsack, near Cologne, Nov. 24, 1920.)

Sulphuretted Dyes.—Sulphuretted dyes, which are probably thiazines, are obtained by sulphurizing β -oxynaphthoquinonearylamides ($O:OH:NR = 1:2:4$); suitable sulphurizing agents are sulphur, alone or in presence of catalysts, solvents or diluents, disulphurdichloride, sulphur sesquioxide or alkali polysulphides, preferably in alcoholic solution at temperatures not exceeding 150 deg. C. The resulting products, if they contain sulphonic or carboxylic acid groups, are acid mordant dyes, or if they are free from such groups are vat dyes; the vat dyeings may be aftertreated with metal salts, preferably chromium salts, giving fast green to black shades. According to examples: (1) The condensation product from *p*-chloraniline and 1:2-naphthoquinone-4-sulphonic acid is heated with sulphur, naphthalene and sulphur iodide or iodine, and the product is worked up by removing the naphthalene by solvent naphtha and free sulphur by sodium sulphide solution, then dissolving the dye in concentrated sulphuric acid, pouring on ice, filtering and washing; the paste gives a yellow hydrosulphite vat dyeing wool violet-black shades which turn to claret-red on treatment with acid, and bluish-green on treatment with chromium salts in acid solution; similar dyes are obtained by the above treatment from the condensation products of 1:2-naphthoquinone-4-sulphonic acid with aniline, *o*-, *m*- or *p*-toluidine, *p*-anisidine, or *p*-phenetidine; (2) the condensation product from 1:2-naphthoquinone-4-sulphonic acid

and *p*-anisidine is treated at ordinary temperature with disulphurdichloride and acetic acid; the product dyes wool in a vat violet shades becoming green on after-treatment with sodium bichromate in an acid bath; similar products are obtained by the action of disulphurdichloride on the condensation products of 1:2-naphthoquinone-4-sulphonic acid with *m*- or *p*-toluidine; (3) the condensation product from *p*-toluidine and 1:2-naphthoquinone-4-sulphonic acid is treated with a solution of sulphur in fuming sulphuric acid; the product is a sulphonic acid dyeing wool from an acid bath green shades with chrome mordants; similar green to greenish-black acid mordant dyes are obtained from the condensation products of aminosalicyclic acid or aminocresotinic acid with 1:2-naphthoquinone-4-sulphonic acid by treatment with disulphurdichloride or sulphur sesquioxide, and a black acid mordant dye by treating with sulphur sesquioxide the condensation product from *p*-nitraniline and 1:2-naphthoquinone-4:6-disulphonic acid; (4) the condensation product from amino-N-ethylcarbazole and 1:2-naphthoquinone-4-sulphonic acid is boiled with alcoholic sodium polysulphide; the product gives a yellow hydrosulphite vat dyeing wool or cotton green shades which may be afterchromed. (Br. Pat. 151,000, not yet accepted; L. CASSELLA & Co., Frankfurt-on-Main, Germany, Nov. 24, 1920.)

Rubber Sponges.—Rubber sponges are formed so as to have large and small pores in different parts of the sponge, either by vulcanizing together superposed layers of two different compounds which will yield on vulcanization portions having large and small pores, or layers of the same compound one part of which has been masticated more than the other and forms larger pores on vulcanization. Alternatively, a mixture of the two compounds is vulcanized while supported in a shallow vessel of water with its lower part dipping into or just above the water. A compound which yields on vulcanization small pores consists of para rubber, milk of sulphur, lithopone, crimson sulphide of antimony or vermillion, ceresin wax, pine oil, together with ammonium carbonate or amyl acetate. In a compound for yielding large pores, larger proportions of carbonate or amyl acetate are used, precipitated chalk and zinc oxide are used in place of lithopone and turpentine may partially replace pine oil. (Br. Pat. 151,084. G. W. BELDAM, London, and A. U. B. RYALL, Brentford, Middlesex; Dec. 1, 1920.)

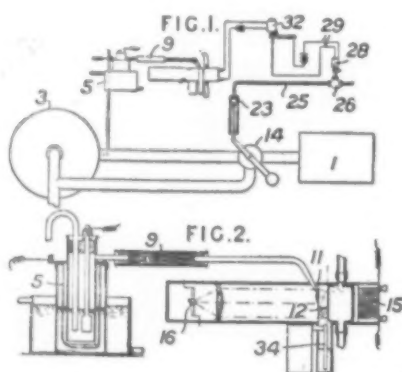
Cyanides.—In the production of cyanides by the reaction of free nitrogen or a mixture of an alkali or alkaline-earth metal or compound, carbon and a catalyst, the catalyst, such as iron manganese, nickel or copper, is introduced in the form of a compound not containing any element other than carbon, hydrogen, oxygen and nitrogen, and is reduced at a temperature below 550 deg. C. Iron hydroxide prepared by precipitating ferrous sulphate with ammonia, and iron oxalate are mentioned. (Br. Pat. 151,098. C. T. THORSELL and H. L. R. LUNDEN, Gothenburg, Sweden; Dec. 1, 1920.)

Retting Flax.—In obtaining fibers from flax, the straw, prior to retting, is treated in one stage, or in a number of stages extending over successively increasing periods of time, with an alkaline solvent to remove the whole or a greater portion of the gum and resin compounds, and the retting operation is carried out in an alkaline medium. A natural soda, such as Magadi soda, occurring in East Africa, may be used, and in the

retting operation, which is preferably effected at 80 to 95 deg. F., the liquid is continuously aerated and circulated. (Br. Pat. 151,143. L. A. JOHNSON, Uasin Gishu, East Africa Protectorate; Dec. 1, 1920.)

Alumina; Basic Aluminum Nitrate.—A solution of aluminum nitrate is evaporated to distil off dilute nitric acid, and water, steam or fresh solution is added so as to keep the temperature constant (about 140 deg. C.) until the bulk of the alumina is precipitated as a crystalline basic nitrate which is practically free from iron even if the solution is ferruginous. It is advantageous to treat solutions containing calcium or sodium nitrate, which remains in solution in the mother liquor. Such solutions may be obtained by adding some base or salt such as limestone to the nitrate solution before heating. Alternatively the solution of nitrate to which such a base or salt has been added or from which some acid has been distilled off may be heated under pressure in an autoclave to effect the precipitation of the basic nitrate. The basic nitrate obtained as above described is heated to obtain alumina and nitrogen oxides which are converted into nitric acid. The mother liquor is treated with nitric acid to convert the alumina content to normal nitrate and the solution is evaporated until aluminum nitrate crystallizes out and may be returned to the original solution and the remaining mother liquor is evaporated to dryness to recover the sodium or calcium nitrate. (Br. Pat. 151,259, not yet accepted. NORSKE AKTIESELSKAB FOR ELEKTRO KEMISK INDUSTRI, Christiania; Dec. 1, 1920.)

Automatic Detector for Arsenic in Gases.—In apparatus for regulating production, a sample of the initial material is withdrawn and is passed to the testing apparatus which acts in such a manner that the presence of an undesirable substance in the sample causes a variation in the quantity or character of radiant energy



ARSENIC DETECTOR

such as light projected through the apparatus, and the variation so produced is utilized to operate means controlling the process of production. The invention is described with reference to the manufacture of sulphuric acid by the contact method, the control depending on the presence of arsenic in the reaction gases. Thus, a sample of the gases is passed to an electrolytic Marsh apparatus 5, the gases from which, after purification in a tube 9, are burned at the jet 11, the flame impinging on a quartz glass or like transparent screen 12 arranged between a source of light 16 and a light-sensitive cell 15; if arsenic is present, a mirror is formed on the screen 12 and serves to cut off more or less the light falling on the cell 15. The latter is in circuit with a relay 32, and the increase in resistance in

the cell 15 consequent on the cutting off of the light actuates the relay to close a circuit 29 and to energize a solenoid 28 controlling through a valve 26 the supply of fluid under pressure in the pipe 25; opening of the valve 26 actuates a piston 23, which in turn operates the main three-way valve 14, so that if arsenic is present in the gases these are bypassed back to the purifying apparatus 3. The screen 12 is periodically cleaned by a wiper 34, and if the impurity is no longer present, the relay 32 comes into action to open the circuit 29 and to de-energize the solenoid 28, and the valve 14 then returns to its original position to pass the gases to the contact apparatus 1. In other instances—for example, in the case of liquids—the control may be based on the extent to which the plane of polarization of light is rotated, or on variations in the refractive index, or it may depend on the fact that the objectionable constituent yields a colored product on treatment with a chemical indicator, in which case a source of light of the complementary color would be employed. (Br. Pat. 151,328; L. LOGAN, Arlington, Mass., Dec. 8, 1920.)

Cyanamide.—Cyanamide practically free from dicyandiamide is obtained in solution by supplying successive quantities of calcium cyanamide to water or a cyanamide solution while supplying enough carbon dioxide to maintain the solution neutral or only slightly alkaline. By starting with a cyanamide solution very strong solutions can be obtained. The reaction is effected at a temperature not above 70 deg. C., and the carbon dioxide is preferably supplied under pressure, being blown into the solution by nozzles; or other means of bringing the gas into intimate contact with the liquid may be employed, such as beaters; or the solution containing calcium cyanamide may be sprayed into an atmosphere of carbon dioxide. The carbon dioxide may be pure or mixed with other gases, as, for instance, combustion or lime kiln. (Br. Pat. 151,583, not yet accepted; WARGONS AKTIEBOLAG and J. H. LIDHOLM, Wargon, Sweden; Dec. 8, 1920.)

Alkali Silicates.—In order to obtain a soluble alkali silicate of high silica content, the product obtained by the fusion of alkali and silica is dissolved in water and an acid then added, whereby gelatinous silicic acid is thrown down, and this precipitate by continued agitation is made to re-dissolve in the solution. The acid, preferably sulphuric acid, may be added in the form of spray; and after the subsequent operation of agitation or grinding, the solution may be evaporated to dryness. Moreover, to increase the fusibility of the alkali and silica, a little borax may be employed in the fusion process. (Br. Pat. 151,339. F. J. PHILLIPS, London, and E. J. ROSE, Therwood; Dec. 8, 1920.)

Calcium Phosphate.—Natural tricalcic phosphates are mechanically treated to obtain two fractions, one of rich granules containing a high percentage of phosphate, and the other of a mixture containing calcium carbonate and phosphate in so fine a state of division as to be assimilable by the roots of plants. The nodules of natural phosphate are first broken down and then treated in a rotary disintegrator through which a blast of air is directed. By this means the granules of phosphate are freed from the carbonate dust which covers them and the mixture is carried away to chambers where the two fractions separate out according to density. (Br. Pat. 151,684. W. P. THOMPSON, Liverpool, Compagnie des Phosphates de Constantine, Paris; Dec. 8, 1920.)

Current Events

in the Chemical and Metallurgical Industries

Patent Office Bill Hearings This Week

Hearings on the Patent Office bill, with its rider authorizing the Federal Trade Commission to administer Government patents, will begin Jan. 5. The hearing is before the conference committee of the two houses of Congress. The Patent Office bill proper has passed each house. The rider was attached by the Senate.

Representatives of chemical industries are to be heard as to the possible effects of extending a reward to Government employees for such inventions as they may develop. Some are afraid that the effect of this reward will be detrimental to the outside inventors, in that the Government employee could pursue his inventive work while on the Government payroll and with the Government's facilities. It is argued that the tendency among Government employees would be to neglect the regular research work and concentrate on a device or a method which promised personal pecuniary reward. The conference committee expects to hear each side of the case before taking action on the bill.

Progress of American Engineering Council

The Executive Board of American Engineering Council met in New York on Dec. 17, with all members present excepting A. M. Greene. Two new members of the Board were elected, W. B. Powell, Buffalo Engineering Society, representing District 1, New York and New England States, and Gardner S. Williams, Grand Rapids Engineering Society, representing District 2, Michigan, Wisconsin and Minnesota.

President Hoover appointed the following standing committees:

Procedure.—Calvert Townley, chairman; Herbert Hoover, ex officio; W. E. Rolfe, D. S. Kimball, J. Parke Channing, L. W. Wallace, L. P. Alford.

Constitution and Bylaws.—W. B. Powell, chairman; C. F. Scott, D. S. Kimball.

Publicity and Publications.—L. P. Alford, chairman; H. W. Buck, H. E. Howe.

Membership and Representation.—J. F. Oberlin, chairman; L. W. Wallace, A. S. Dwight.

Finance.—William McClellan, chairman; E. Ludlow, C. Townley, L. W. Wallace, ex officio.

Public Affairs.—J. Parke Channing, chairman; Fred J. Miller, L. B. Stillwell.

In discussing the immediate program of Council, Mr. Hoover announced that he had called together engineers in various cities and found that while they were favorably disposed toward the Federation, there was a strong trend toward territorial as distinguished from national organization. One of the obstacles to uniting territorial organizations in the Federation is the question of dues. Another complication is the membership of numerous individuals in more than one society. Deeming the question of territorial organization of vital importance, Mr. Hoover suggested the appointment of a committee to canvass the situation carefully. After considerable discussion the matter was referred to a special committee which will include the six district delegates.

Necessary action was taken to make it possible for certain activities of Engineering Council to be taken over by the new organization as soon as the United Engineering Societies has passed officially on the proposed transfer. In this event President Hoover will appoint the necessary committee of American Engineering Council to take over and continue the uncompleted work of Engineering Council's committees.

Action was taken to amend section 9, paragraph 6, of the bylaws so that committee members can be selected from societies other than those now belonging to the Federation, thus making it possible for civil engineers and others not now affiliated with the Federation to co-operate in committee work.

Council voted not to affiliate with the United States Chamber of Commerce. It also appropriated \$1,000 as an initial fund for publicity work, and authorized the committee on publicity and publications to establish a board of engineering editors. It was voted to pay the expenses of members of the Executive Board for attendance at meetings. A special committee reported on candidates for executive secretary of the organization, but no action was taken. The place of the next meeting, which will be held Feb. 11, was left to the discretion of the president.

Patents Obtained by Department of Agriculture Employees During 1920

During the last fiscal year thirty-five patents were allowed for inventions by employees of the United States Department of Agriculture the benefits of which are dedicated to public use. Thirty applications for patents were prepared by the department's office of the Solicitor during the year, some of which were pending at the close of the fiscal period.

The patents allowed cover a wide scope and some of them are believed by the department to be highly valuable to the public. The list of those allowed during the year includes cane stripping comb, manufacture of cymene sulphonic acid, synthetic ammonia (2), photographic sensitizing dyes (2), new insecticide, production of ammonia, curing tobacco, atmometer, phosphorus and phosphorus acid, dextrine, process for removal of hydrofluoric acid from phosphoric acid, bleaching wood, improvement in the synthetic manufacture of thymol, vanillyl amine, vanillyl acyl amides and production thereof, and fruit grader and sizer.

Applications for patents on the following inventions were pending at the close of the year: Method of manufacturing decolorizing carbon, process for the manufacture of naphthalene sulphonic acids, tree trimming and harvesting machines, panoramic camera attachment, process of sublimation, adhesive, apparatus for controlling reactions between gases (2), ammonium nitrate, insecticide and fungicide, grain samplers, malt sirup (2), process of extracting soluble albumen from whey, manufacture of furfural and volatile organic acids from corncobs, manufacture of furfural and volatile organic acids from corncob pentosan, preserving

apples, grain sampler, apparatus for sterilizing fruit juices, new and improved types of bread, manufacture of sweet potato sirup, new process for preparing sirup from sugar beets, protosensitizing dyes of the isocyanine type, gelatine or glue free from mineral matter, acids, or alkalis, and a process for preparing same.

The Government and the people of the United States are entitled to make use and sell the inventions disclosed by these patents freely and without the payment of royalty to the patentees.

No Appropriation for Chemical Industries

The Committee on Appropriations of the House of Representatives used the knife relentlessly on the requests made by the Bureau of Mines for funds for its work during the next fiscal year. The \$125,000 asked for non-metallic and chemical industries research went out altogether, as did the \$30,000 for low-temperature research and the \$29,920 requested for aluminum research. For the most part, the committee allowed no increases over the appropriations for the current fiscal year. The only new item in the bill, as reported on Dec. 29, was \$50,000 for enforcing the oil land-leasing regulations. The bureau had requested \$132,390 for that work. The total appropriation carried by the bill for the Bureau of Mines was \$1,357,300.

In addition to the carefully written justifications prepared in support of these estimates, Dr. F. G. Cottrell, the director of the bureau, argued in person before the Committee on Appropriations.

In support of the aluminum research, Dr. Cottrell pointed out to the committee the possibility of obtaining aluminum production from sources and ores not now being utilized. He also emphasized the need for better and cheaper methods of aluminum production.

The failure of the committee to allow \$30,000 for low-temperature research is regarded as particularly lamentable, since the entire installation for that work has been turned over to the Bureau of Mines, without expense, by the War Department.

The War Department purchased complete equipment for the cryogenic laboratory, which was set up by the Bureau of Mines in its own offices. The co-operative agreement provided that the laboratory was to become the property of the Bureau of Mines after the War Department work had been completed.

The committee allowed \$200,000 for the operation of the mining experimenting stations. This is the amount of the current appropriation. The bureau has requested \$270,000 for its work in this direction during the next fiscal year.

Important Legislation on the Tapis

The first week of the new year saw many chemists journeying to Washington. Three important matters of particular interest to the chemical industries have come up for active consideration on the part of Congress. The chemical schedule of the new tariff bill will be considered at the first of the series of hearings to be held by the Committee on Ways and Means. The Patent Office bill, with its rider authorizing the Federal Trade Commission to administer patents granted to Government employees, comes up for hearings beginning Jan. 5. The third matter is the bill authorizing the creation of the United States Fixed Nitrogen Corporation.

Since so many chemical activities come within the infant industry class, the need for a protective tariff is

felt by a large number of the subdivisions of the industry. As a result these hearings are expected to be of unusual interest.

In view of the apparent determination of some of the members of the conference committee on the Patent Office bill to force it through, rider and all, the hearings before that body seem to be the only hope that the opponents of the rider have to secure the defeat of the legislation.

There is increasing hostility to the Fixed Nitrogen Corporation bill, especially in view of the changed economic situation. The manufacture of fertilizer materials on a large scale at this time by the Government is denounced very strongly in some quarters. Efforts are being made to stir up opposition to the measure in the Senate. A very little opposition aroused now, with the end of the short session in sight and with unprecedented congestion of the legislative program, would be all that is necessary to prevent passage of the bill. Should the effort in the Senate fail, there is a good chance to block it in the House, it is believed, owing to the disinclination to authorize any further appropriations. The present situation in the nitrate market is such that it is not believed to be feasible to finance the corporation from funds which might be obtained from the sale of the War Department's reserve of sodium nitrate.

British Dye Bill

The text of the British dye bill, which passed the House of Commons Dec. 20, is as follows:

With a view to the safeguarding of the dye-making industry, the importation into the United Kingdom of the following goods—that is to say, all synthetic organic dyestuffs, colors and coloring matters, and all organic intermediate products used in the manufacture of any such dyestuffs, colors or coloring matters—shall be prohibited.

Goods prohibited to be imported by virtue of this act shall be deemed to be included among the goods enumerated and described in the table of prohibitions and restrictions inwards contained in section 47 of the customs consolidation act, 1876, and the provisions of that act and any act amending or extending that act shall apply accordingly.

The Board of Trade have power by license to authorize, either generally or in particular case, the importation of any of the goods or any class or description of the goods prohibited to be imported by virtue of this act.

For the purpose of advising them with respect to the granting of licenses the Board of Trade shall constitute a committee consisting of five persons concerned in the trades in which goods of the class prohibited to be imported by this act are used, three persons concerned in the manufacture of such goods, and three other persons not directly concerned as aforesaid. Such one of the last-mentioned three persons as the board shall appoint shall be chairman of the committee.

For the purpose of providing for the expenses incurred by the board in carrying this act into execution, the board may charge in respect of a license a fee not exceeding £5.

Subject to compliance with such conditions as to security for the re-exportation of the goods as the Commissioners of Customs and Excise may impose, this act shall not apply to goods imported for exportation after transit through the United Kingdom or by way of transshipment.

Anything authorized under this act to be done by the Board of Trade may be done by the president or a secretary or assistant secretary of the board or by any person authorized in that behalf by the president of the board.

The provisions of this act shall continue in force for a period of ten years from the commencement thereof and no longer.

This act may be cited as the dyestuffs (import regulation) act, 1920.

Bill for Federal Manufacture of Atmospheric Nitrogen Expected to Pass the Senate

The bill providing for federal manufacture of atmospheric nitrogen is expected to pass the Senate, but strong opposition to the measure has developed in the House, where its course is likely to be more difficult. Senator Underwood of Alabama, the minority leader, has given notice that the minority will employ such methods as are available to insure its passage.

The opposition in the House is based for the most part on the probability that the enterprise will call eventually for large appropriations. The bill provides for the financing of the proposed United States Fixed Nitrogen Corporation by the sale of a portion of the War Department's reserve of nitrate of soda. Now that the price of nitrate has declined materially since the bill was drafted, it is feared that it would not be wise to attempt to raise the \$12,500,000, for which the bill calls, from the sale of the nitrate reserve, since at present prices it would deplete that reserve unduly.

Book Reviews

PLANTATION RUBBER AND THE TESTING OF RUBBER. By G. Stafford Whitby. 555 pages. New York: Longmans, Green & Co., 1920. Price \$9.50 net.

Although there have been extremely few contributions to the technology of rubber goods manufacture, the literature on crude rubber is rather abundant. This is due in a great measure to the fact that both the Dutch and the British went into the systematic planting of rubber trees before the beginning of this century.

The author of this work has divided his book into two almost equal parts. The first part treats of such topics as methods for obtaining the milk from the rubber trees, collection of this latex, coagulation of the latex, conversion of the coagulated milk into sheets, and the process of "smoking" sheet rubber. In Part II of his book the author has presented many data on rubber from the viewpoint of the physical chemist. He has discussed such subjects as Young's modulus, Hooke's law, the stress-strain curve for rubber, and tensile tests. In his discussion of tensile strength and elongation the author passes over the Henry Scott testing machine with a two-line note, which is disappointing for American readers. The literature references are for the most part English and Dutch, although one finds casual references to the work of Kratz, Flower, Tuttle and Cranor in the United States.

Although the rubber industry was born the day Good-year discovered vulcanization in 1839, it was not until about 1910 that serious scientific work was done in the field of rubber chemistry. Even the theory of vulcanization was not proposed before Carl Otto Weber in 1902 published his now historic book. The rubber industry was in fact a "house of mystery" until the demands made by consumers of rubber goods compelled the manufacturers to invite chemists into their plants. And so it comes that we find in the present text books such phrases as "co-efficient of vulcanization," "accelerated aging tests," "optimum cure" and "state of cure."

Forty-four pages have been devoted to a bibliography in which the author has discovered 350 names of writers on rubber topics in book and periodical literature. Unfortunately he has omitted all mention of the valuable papers which have appeared in *CHEMICAL & METALLURGICAL ENGINEERING* during the past five years. All reference to synthetic rubber has been carefully deleted from the book, as well as from the bibliography, but a considerable number of unimportant publications have been noted. In spite of this the author has rendered a service of unusual value to

rubber investigators who desire to find references on plantation rubber and rubber testing.

In general the short-sentence style has been used, but sentences of 120 words (page 261) should be modified in later editions. Aside from this the text is readable, the subject matter true, the proof carefully corrected, and a great deal of material on the physics and physical chemistry of rubber has been published in book form for the first time. In this country the book will probably be of greater value to university men than to manufacturers of rubber goods.

FREDERIC DANNERTH.

Obituary

Dr. HENRY A. BUMSTEAD, professor of physics at Yale University, who had been on leave of absence serving as chairman of the National Research Council, died on a train en route from Chicago to Washington on Dec. 31. He had just taken a very active part in the Christmas week meetings of the various scientific societies. The death of Dr. Bumstead comes as a shock to the scientists of the country and particularly to the National Research Council, where he was in the midst of a constructive program for the work of that institution. The services rendered by Dr. Bumstead during the war were particularly notable. As an attaché of the American Embassy at London he was in immediate charge of the exchange of confidential scientific data with the Allies. Due to his twenty-seven years of service as an instructor at Yale, Dr. Bumstead has influenced the thought of many thousands of students. As a result of his particularly attractive personality, these students have clung to him with unusual affection. The laboratory at Yale which was under his direction is regarded as one of the finest in the world. Dr. Charles Walcott, the vice-chairman of the National Research Council, will succeed Dr. Bumstead at least temporarily as the active chairman of the Council. Dr. Bumstead was fifty years old and was graduated from Johns Hopkins University in 1891, later receiving his doctor's degree from Yale.

Personal

RICHARD H. CATLETT has resigned his position as production manager of the Taylor Chemical Co., Penn Yan, N. Y., and is now chemical engineer with the Lewis Recovery Corp., Boston, Mass.

CHARLES A. EDWARDS, for many years manager of the Portland, Ore., office of A. O. Anderson & Co., has severed that connection to become head of the Portland Vegetable Oil Milling Co., Portland.

Dr. SAMUEL EYDE, joint inventor of the Birkeland-Eyde arc process for nitrogen fixation, arrived in New York on Dec. 30. He plans to make an extensive visit in the Canadian nickel territory.

Dr. CARL HERING of Philadelphia, Pa., has moved his office from 210 South 13th St. to 1317 Spruce St.

Dr. J. A. MONTGOMERY, formerly chief chemist for the Structural Materials Research Laboratory, has resigned to become chief chemist for the Borromite Company of America, 105 West Monroe St., Chicago, Ill.

H. L. MOYLER resigned his position Nov. 1 as assistant superintendent of acid plants, Naval Proving Grounds, Indian Head, Md., to become general supervisor of acid production, Monsanto Chemical Works, Plant B, East St. Louis, Ill.

Dr. M. C. TEAGUE, formerly gas chemist at the Pittsburgh station of the Bureau of Mines, is now research chemist with the United States Rubber Co., 561 West 58th St., New York City.

Current Market Reports

The Chemical and Allied Industrial Markets

New York, Jan. 3, 1921.

Reflections of the holiday week were apparent in the chemical market and trading in most quarters was reported quiet. However, the tone of the general market is steady. The trade is looking forward to the new year with confidence, although it is generally conceded that business will probably be slow during the next few weeks. Opinions of the dealers and manufacturers show a feeling more hopeful for a resumption of activity. Those close to the inside workings of the market stated that sellers are plucking up more nerve and that buyers have been turned down on several occasions because they refused to meet an advance in lately prevailing prices.

The extent of business has not improved much on the surface of the market and it is not expected to improve materially until the holiday excitement and inventory periods are out of the way. There is no denying that buyers have shown more interest in the market than for several weeks and sales have been freer although of small individual volume.

Solid caustic soda displayed a firmer tendency in the open market and offerings of standard material were not much in evidence. Buying was considered good in several quarters and rumors were current of large interests operating. Spot prices ranged from \$3.75 to \$3.85 per 100 lb. for carlots. Occasional odd lots moved at a shade under this figure through brokers. Makers were still holding contract prices at 3½c. per lb., basis 60 per cent, f.o.b. works, over next year.

Producers reported quiet trading in *yellow prussiate of soda*. Large manufacturers were willing to book contracts at 18c. per lb., but stated that consumers were not taking much interest in futures. Second hands are doing business in small lots at prices ranging from 17c. to 17½c. per lb. Makers of *silicate of soda* quote \$2.90@\$3 per 100 lb. for the 60 deg. Bé. in large lots and up to 3½c. per lb. for small lots. Business was reported quiet, with sales mostly moderate for home and abroad. The 40 deg. test is offered at \$1.15@\$1.25 per 100 lb. in carload lots and up to \$1.50@\$1.75 in small quantities. Single bags of *soda ash* were held at \$1.90@\$2 per 100 lb. at the works for prompt shipment. Offerings continued limited and the market showed a steady tendency. Resale lots for export were quoted at \$1.85@\$1.90 with scattered transactions reported. Barrels ranged about 5c. per 100 lb. advance. Contracts continued to be quoted by producers for 1921 shipment at \$1.82½@\$1.90, basis 48 per cent, f.o.b. works.

Manufacturers of *sodium sulphide* are trying to keep the price of the 60-62 per cent at 7c. per lb. for drums in carload lots. Resale material was evident on the market at lower prices and sales were made down to 6c. per lb. Resale *bleaching powder* in large drums was on the market at 2½c. per lb. and it seemed possible that some interests would shade this figure on firm business. The supply could not be called heavy, but the demand gave the market an easy appearance. Producers of *glaubers salt* reported prices at 1½c. per lb. in bags. Barrels were held at \$2.05 per 100 lb. for carlots and \$2.35 in smaller quantities. Some foreign *oxalic acid* was offered on the market as low as 17½c. per lb., but most dealers gave 18½c. as the prevailing price for prime American material and prices extend all the way up to 20c. per lb. depending entirely upon brand, quantity and seller. Trading has remained quiet in this commodity, as prices are somewhat above the views of buyers.

Resale *formaldehyde* is commanding 18½c. per lb. in barrels on the spot market and business was known to have been placed at this level. Round lots are very scarce and in some quarters 19c. is the best offering for goods ex warehouse. The undertone was reported very steady. *White granular sal ammoniac* was offered on the open market at 10½@11c. per lb., with little trading reported at these low

figures. Odd lots of the gray material were available at 9½@10c.

SODIUM PRODUCTION

According to a recent report by the United States Geological Survey, the production of sodium compounds in the United States was slightly less during 1919 than it was in 1918, the total for 1919 being 9,393,749 short tons, as compared with 10,199,493 for the preceding year. The total value of these products declined from about \$143,000,000 in 1918 to slightly more than \$121,000,000 in 1919. This total includes the production of common salt, which accounts for practically 7,000,000 short tons of the total for both years. About 500,000 tons of sodium chloride was imported in 1919.

During 1919, exports of many of the sodium compounds were heavier than in 1918. The use of sodium products instead of potassium is being continued and has been materially increased because of sodium compounds being cheaper.

The following is a table of various important sodium compounds produced during 1918-1919:

	1918, Tons	1919, Tons
Acetate soda.....	2,622	2,426
Bicarbonate soda.....	118,535	134,962
Bichromate soda.....	26,526	28,334
Soda ash.....	981,054	1,390,628
Yellow prussiate soda.....	3,437	4,525
Caustic soda.....	355,466	513,363

COAL-TAR PRODUCTS

Despite the holiday recessions, offerings and inquiries were more in evidence. This showed a renewal of interest was taking the place of a long period of dullness. There were no inquiries of large enough volume to mention. Operations in some markets are beginning to show a little life and sharp-sighted merchants see that the curtailment of production and low prices have gone pretty near the limit. They also believe that stocks of many kinds have reached a level where buying now is a safer proposition.

The crude market was also a dull affair with little trading in any quarter. *Naphthalene* flakes and balls showed a firmer tendency, although trading was of a light nature. Only very small lots of *orthotoluidine* were in demand and supplies were easy, with prices ranging from 30c. to 35c. per lb. Recent trading in *paranitrophenol* has been limited to small lots on a basis of 75@80c. per lb. Producers of *beta naphthol* reported a fair volume of supplies available at 40@45c. per lb. Second hands are still offering goods and 38c. seems possible on distressed lots. *Diethylaniline* was offered in very small quantities among second hands and producers reported conditions quiet. Supplies were fairly easy at \$1.35@\$1.45 per lb.

VEGETABLE OILS

The market on vegetable oils remained quiet and uninteresting during the holiday week. Prices in most cases were nominal, with no large business consummated. Crushers of *linseed oil* reported that the inquiry was almost at a standstill so far as round lots were concerned. Operators were reluctant to name 78c. per gal. without any real bids to work upon. Consumers were offered raw linseed at less than 78c. for January-April shipment. Producers of No. 1 U.S.P. *castor oil* quoted the market at 12c. per lb. in barrels. The technical grade has been revised to 11½c. per lb. The outside market has sold the No. 3 type as low as 9½c. *Crude corn oil* was unsettled due to the drop in cottonseed oil, and the market closed nominal at 6½c. per lb., sellers' tanks, for immediate shipment from Chicago. No business was reported in *coconut oil* in carlots during the week. Prices held on an even basis, both here and on the Coast. Domestic Ceylon type oil held at 9c. per lb. sellers' tanks, f.o.b. Coast, with the Manila at 9½c. for January-March shipment.

The market on *palm oil* was unsettled, with lower prices in evidence in some directions for future. Lagos for shipment closed nominally at 7½c. per lb. Niger closed at 7½c. for prompt shipment from abroad. Offerings for *soya bean oil* appeared more plentiful and slightly easier prices for prompt shipment oil were noted. Inquiry was dull. *Soya bean oil* for December shipment from the Coast was offered at 5½c. per lb., sellers' tanks, while there were sellers of January-March at 5½c.

Chemical Market for 1920

During the latter half of 1920 the chemical industry underwent the most radical change in its history. Liquidation and all that goes with it exerted full force on the chemical market and prices yielded in almost every important item. Tight collections, efforts to ship goods prior to the advanced freight rates that became effective Aug. 26, 1920, and the influx of surplus stocks held by large consuming plants have been factors all working against the maintenance of a steady market. Reports from New England noted a state of acute quietness among most of the dye and bleaching plants. This condition was also reflected all through the textile industry. Finished textile products were not in demand and factories had to close their doors to thousands of employees. Several of these plants offered bichromate, prussiate and caustic soda for resale in the open market through various dealers. Arrivals were often considerably under the market to facilitate a quick sale.

The American export trade during the first six months of 1920, helped by Europe and Japan, established the United States as the leading chemical center of the world. Prices were reflected by the persistent demand and for several months speculators who had contracted long before were reaping the benefit of a soaring market. Spot stocks were partly wiped out and with the shortage of fuel, railroad entanglements and general existing abnormal conditions large producers were forced to shut down their plants. Germany's future after the war was another situation that kept foreign buyers on edge. When it was clearly evident that the German industry was not in a position to supply the rest of the civilized world, those who had been holding off flooded the American market with voluminous orders for miscellaneous chemicals and dyestuffs. This delicate situation brought speculation to its highest point and commodities were known to have advanced 10 to 15c. per lb. within twenty-four hours. Japanese buyers in their over-enthusiasm joined in the procession and played the speculative game harder than any of their neighbors. It was Japan that helped prices reach their highest peak and also their lowest level. Japan went into the market as a blind buyer and within a short period realized that she had bought enough for her requirements for the next three years. The surplus purchasing had a mortifying effect on Japanese financiers.

COMPARATIVE PRICES OF GENERAL CHEMICALS, JANUARY TO DECEMBER, 1920

	Jan.	June	Oct.	Nov.	Dec.
Acetic acid, 28%, lb.	\$0.02½	\$0.03½	\$0.03½	\$0.03	\$0.03
Acetic acid, glacial, lb.	.12	.16	.11	.11	.10½
Muriatic acid, 20 deg., 100 lb.	1.75	3.50	2.00	1.85	1.85
Nitric acid, 40 deg., lb.	.06½	.07½	.07½	.07½	.07
Oxalic acid, lb.	.33½	.58	.40	.25	.18½
Sulphuric acid, 66 deg., ton.	21.00	23.00	21.00	21.00	21.00
Acetate of lead, lb.	.12½	.13½	.14½	.14½	.13½
Ammonia alum, lump, lb.	.04	.04½	.04½	.04½	.04½
Potassium alum, lump.	.07½	.07½	.05½	.05½	.05½
Aluminum sulphate, iron free, lb.	.02½	.03	.05	.04	.03½
Aluminum sulphate, comm., lb.	.01½	.02	.04½	.03	.02½
Aqua ammonia, 26 deg., lb.	.07	.09	.09½	.07½	.06½
Sal ammoniac, white, lb.	.14½	.17½	.14	.12	.10½
Arsenic, white, lb.	.10½	.14½	.14	.13	.11½
Barium chloride, ton.	80.00	150.00	120.00	100.00	75.00
Bleaching powder, lb.	.02½	.06½	.07½	.06	.03½
Carbon tetrachloride, lb.	.11	.11	.13½	.13	.12
Cobalt oxide, lb.	1.50	2.00	4.00	4.00	3.90
Copper sulphate, lb.	.08½	.08	.08	.07½	.06½
Cream of tartar, lb.	.55	.56	.52	.45	.38
Epsom salt, U. S. P., lb.	.02½	.04½	.04	.03½	.03
Formaldehyde, lb.	.40	.51	.40	.23	.18½
Glauber salt, lb.	.01½	.02	.02½	.02	.01½
Lead arsenate, paste, lb.	.16	.16	.16	.15	.13
Bichromate potash, lb.	.30	.42	.30	.22	.17½
Carbonate potash, 80-85%, lb.	.23	.21	.19	.15	.12
Caustic potash, 88-92%, lb.	.30	.28	.25	.17	.14
Muriate potash, ton.	150.00	115.00	105.00	100.00	100.00
Nitrate potash, lb.	.13½	.13½	.14	.11½	.11½
Permanganate potash, U. S. P., lb.	.60	.85	.70	.65	.60
Prussiate potash, yellow, lb.	.37	.36	.38	.36	.33
Acetate soda, lb.	.06½	.12	.11	.08	.06½
Soda ash, light, 100 lb.	2.00	3.25	2.50	2.00	1.85
Bichromate soda, lb.	.19	.32	.16	.11	.09½
Caustic soda, solid, 100 lb.	4.35	6.50	4.00	4.00	3.75
Chlorate soda, lb.	.12	.12	.12	.11	.10
Cyanide soda, lb.	.28	.35	.34	.26	.23
Fluoride soda, lb.	.14	.19	.21	.20	.17
Nitrate soda, lb.	.03	.03½	.03	.02½	.02½
Prussiate soda, lb.	.25	.26	.24	.19	.17½
Salsoda, 100 lb.	1.25	1.25	2.00	2.00	2.00
Sulphide soda, 60%, lb.	.05	.10½	.09	.07½	.06½
Tin oxide, lb.	.60	.65	.52	.50	.50

Credits were immediately stopped and Japan shifted from the position of leading buyer to the selling end in a vain attempt to cover her great losses. Failures among large business interests and banks followed on the heels of this change, and it was not long after that the rest of the world followed suit. Cancellations on old contracts bought by domestic dealers and foreign orders were noted. Steamers docked with cargoes of returned surplus material. All this was dumped on the American market for resale. It is in this condition that the chemical market finds itself at the turn of the year.

Perhaps the outstanding feature of the chemical market during the past year was the unique position of the dealer with his resale material and prices. During the latter part of 1919, jobbers foreshadowed a rising market and contracted heavily with manufacturers at low figures. These chemicals were later turned over at huge profits when the scarcity arose. Since June, however, prices have continually been on the decline and in some commodities the resale market has been consistently below the cost of manufacturing. Leading interests are of the opinion that the downward trend has run its course on most of the important items and that the first quarter of 1921 will be the impetus for another strong market that will once more bring out the American chemical industry as the guiding light for the rest of the world.

The Iron and Steel Market

Pittsburgh, Dec. 31, 1920.

In the past week the steel market as a whole has been even quieter than formerly, if such a thing is possible. There has been no open demand to speak of, and prices have not been tested. The view formerly held still obtains, and even more strongly, that the turn of the year will witness a mild resumption of buying. No general movement is expected for January, or even for several months to come, but it is held that complete stagnation cannot in the nature of things prevail for any length of time. The common attitude of buyers has been that they have no quarrel with the market, but simply have no interest in it. They are busy with year-end adjustments, unusually difficult this time, and will wait a more convenient season for developing a definite policy as to making fresh commitments.

OPERATIONS

The general closing of independent steel mills that was predicted in some quarters has not occurred. It is true the rate of operation of the independents as a whole has become very low, averaging perhaps under 25 per cent, but there is not a universal closing. Perhaps half the mills are closed, with those operating running at rates from 25 to 60 per cent.

The United States Steel Corporation is understood to be operating at 92 per cent, or a trifle more, measured by ingots. A very few finishing departments are closed for repairs, but on the other hand some have been working up accumulations of semi-finished material.

WAGES

Wage reductions began to appear some time ago, and it looked as though these were forerunners of a general reduction among the iron and steel producers, or at least among the independents. That impression is now seen to be erroneous. Many steel producers openly express the opinion that the wage reductions made were ill-timed and the example is not being generally followed. It is not a case of producers holding that wages should not be reduced, but that the time is not ripe. It is maintained that the various wage advances more than kept pace with the increase in the cost of living, up to the latter's peak, and that with the decrease in the living cost that has already occurred, with more to follow, the iron and steel producing industry is eventually to be on a materially lower wage basis.

COKE

Additional Connellsville furnace coke contracts for the first half of the new year on the general basis of a 5 to 1 ratio against basic pig iron at valley furnaces have been reported beyond the business noted in last review, and the total is now in the neighborhood of 75,000 tons a month.

Some contracts made a couple of months ago, equivalent to a ratio of about 4½ to 1, are still in existence, but will probably be modified when the furnaces involved have occasion to run. Basic pig iron is quotable nominally at \$33 valley, but the trade is under the impression that at the beginning of January a \$30 price will be recognized by some producers. That would make the coke on a 5 to 1 contract cost \$6, this being regarded as a moderately fair cost in the circumstances, the coke operator having little control over his coal mining cost, which is dictated by the general coal scale even though the Connellsville region is technically non-union. Spot furnace coke can be had without difficulty at \$5.50.

PIG IRON

The pig iron market remains dormant, with merchant furnaces continuing to go out of blast. In western Pennsylvania and Ohio fully half the merchant furnaces are out, and others are to go out shortly. The furnaces accumulate no stocks before blowing out, and as consumers have been reducing their stocks the market situation is very sound in that respect, even though quoted prices almost entirely lack buying support. Quotations are practically nominal at \$35 for foundry and bessemer and \$33 for basic, f.o.b. valley furnaces. It seems safe to predict that next week furnace offerings will establish prices of about \$32 for bessemer and \$30 for basic, while foundry iron may merely sag somewhat.

SEMI-FINISHED STEEL

No interest whatever is manifested in billets and there can hardly be said to be even a nominal market price. In sheet bars all producers are holding firmly to \$47, which is the Industrial Board price of \$42 plus a \$5 advance made last September by the Steel Corporation. It is the contention of some sheet mills that the real market basis is \$42 and that the \$47 price is only temporary. Some customers of the Steel Corporation, however, state that they have received no intimation of an intention to supply sheet bars in 1921 at any other price than \$47. At any rate, some sheet mills are said to be "holding out" for a \$42 price with the independents from whom they usually draw supplies, but a case is yet to be heard of a consumer making a firm bid for a tonnage at \$42.

FINISHED PRODUCTS

In the past few weeks, as already reported, the important finished steel products have declined in the independent market to the Steel Corporation level. Pipe was, and remains, the exception, the independents having a list from \$7 to \$10 a ton above the corporation list. There is a rumor that some of the independents will issue a new and reduced list under date of Jan. 3. Pipe is exceptional among steel products in having shown to date an excellent demand against contracts, with pipe departments generally running full. As the mills should normally carry stocks, there is an opportunity for independents to run on stocks and a reduction in price is not considered absolutely necessary at this time.

RAILS

Contrary to expectations entertained in many quarters, the independent rail mills one by one have reduced their asking prices to the Steel Corporation or Industrial Board level, \$45 per gross ton for bessemer and \$47 for open-hearth. The distribution of rail orders for 1921 replacements will be somewhat heavier in consequence. The Pennsylvania system, which for many years has had almost precisely one-eighth the total ton-mileage of freight movement, has distributed orders for 200,000 tons. The New York Central is taking 175,000 tons or more. It seems safe to predict that the total orders for replacement on the steam roads will be between 1,500,000 and 2,000,000 tons, probably nearer the latter figure. With rails for electric line, industrial use and export, the total output in 1921 is likely to be somewhat over rather than under 3,000,000 tons. This would compare favorably with the average in recent years, but would leave the 4,000,000-ton record of 1906 untouched.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	—	\$0.55 — \$0.60
Acetone.....lb.	\$0.13 — \$0.13½	.13 — .14
Acid, acetic, 28 per cent.....100 lbs.	3.00 — 3.25	3.50 — 3.75
Acetic, 56 per cent.....100 lbs.	6.00 — 6.25	6.50 — 6.75
Acetic, glacial, 99½ per cent, carboys.....100 lbs.	10.50 — 11.00	11.25 — 11.50
Boric, crystals.....lb.	.14 — .15	.15 — .16
Boric, powder.....lb.	.15 — .16½	.17 — .18
Citric.....lb.	—	.52 — .54
Hydrochloric.....100 lb.	1.85 — 2.25	2.75 — 3.00
Hydrofluoric, 52 per cent.....lb.	.15 — .16	.16 — .18
Lactic, 44 per cent tech.....lb.	.10 — .11	.11 — .12
Lactic, 22 per cent tech.....lb.	.04 — .05½	.06 — .07
Molybdenic, C. P.....lb.	4.00 — 4.50	4.50 — 5.00
Muriatic, 20 deg. (see hydrochloric).....lb.	.07 — .07½	.08 — .08½
Nitric, 40 deg.....lb.	.07½ — .08	.08 — .09
Nitric, 42 deg.....lb.	.18 — .18½	.19 — .20
Oxalic, crystals.....lb.	.18 — .18½	.18 — .19
Phosphoric, Ortho, 50 per cent solution.....lb.	.28 — .35	.40 — .50
Picric.....lb.	—	2.30 — 2.40
P. vaginalis, resublimed.....lb.	—	—
Sulphuric, (O deg., tank cars).....ton	—	14.00 — 15.00
Sulphuric, 60 deg., drums.....ton	18.00 — 19.00	—
Sulphuric, 66 deg., tank cars.....ton	21.00 — 22.00	22.50 — 23.00
Sulphuric, 66 deg., drums.....ton	—	—
Sulphuric, 66 deg., carboys.....ton	23.00 — 24.00	—
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	25.00 — 26.00	26.50 — 27.00
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	—	—
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	32.00 — 35.00	40.00 —
Tannic, U. S. P.....lb.	.50 — .55	1.30 — 1.35
Tartaric, tech.....lb.	—	.56 — .60
Tartaric, crystals.....lb.	—	.33 — .35
Tungstic, per lb. of WO.....lb.	—	1.20 — 1.40
Alcohol, Ethyl (nominal).....gal.	—	5.50 — 6.00
Alcohol, Methyl (see methanol).....gal.	—	—
Alcohol, denatured, 188 proof.....gal.	—	.82 — .84
Alcohol, denatured, 190 proof.....gal.	—	.88 — .90
Alum, ammonia lump.....lb.	.04 — .04½	.05 — .05½
Alum, potash lump.....lb.	.05 — .06	.06 — .07
Alum, chrome lump.....lb.	.13 — .13½	.14 — .14½
Aluminum sulphate, commercial.....lb.	.02 — .03	.03 — .03½
Aluminum sulphate, iron free.....lb.	.03 — .03½	.04 — .04½
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.06 — .07	.07 — .08
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.33 — .35	.36 — .38
Ammonium carbonate, powder.....lb.	.14 — .14½	.14 — .15
Ammonium chloride, granular (white sal-ammoniac) (nominal).....lb.	.10 — .11	.11 — .11½
Ammonium chloride, granular (gray sal-ammoniac).....lb.	.1 — .10½	.10 — .11
Ammonium nitrate.....lb.	.09 — .09½	.10 — .10½
Ammonium sulphate.....lb.	.03½ — .04	.04 — .04½
Amylee, tech.....gal.	—	4.50 — 5.00
Amylee, tech.....gal.	—	3.75 — 4.00
Amylee, tech.....gal.	—	—
Arsenic oxide, lumps (white arsenic).....lb.	.10 — .11	.11 — .11½
Arsenic sulphide, powdered (red arsenic).....lb.	.15 — .15½	.15 — .16
Barium chloride.....ton	75.00 — 80.00	85.00 — 90.00
Barium dioxide (peroxide).....lb.	.24 — .25	.26 — .27
Barium nitrate.....lb.	.10 — .10½	.10 — .11
Barium sulphate (precip.) (blanc fixe).....lb.	.04 — .05	.05 — .06
Bleaching powder (see calc. hypochlorite).....lb.	—	—
Blue vitriol (see copper sulphate).....lb.	—	—
Borax (see sodium borate).....lb.	—	—
Bromine (see sulphur, roll).....lb.	.50 — .52	.54 — .56
Bromine.....100 lb.	2.00 — 2.25	—
Calcium acetate.....lb.	.04 — .04½	.04 — .05
Calcium carbide.....ton	30.00 — 32.00	33.00 — 35.00
Calcium chloride, fused, lump.....lb.	.02 — .02½	.03 — .03½
Calcium chloride, granulated.....lb.	.02 — .03	.03 — .03½
Calcium hypochlorite (bleach'g powder).....lb.	—	1.25 — 1.30
Calcium peroxide.....lb.	—	.18 — .20
Calcium phosphate, monobasic.....lb.	—	.07 — .08
Calcium sulphate, pure.....lb.	—	.90 — .95
Camphor.....lb.	.08 — .08½	.09 — .09½
Carbon disulphide.....lb.	.11 — .11½	.11 — .12
Carbon tetrachloride, drums.....lb.	—	.60 — .75
Carbonyl chloride (phosgene).....lb.	—	—
Cautic potash (see potassium hydroxide).....lb.	—	—
Cautic soda (see sodium hydroxide).....lb.	.09 — .09½	.10 — .10½
Chlorine, gas, liquid-cylinder (160 lb.).....lb.	—	.43 — .50
Chloroform.....lb.	—	3.90 — 4.00
Cobalt oxide.....lb.	—	—
Copperas (see iron sulphate).....lb.	.22 — .22½	.24 — .25
Copper carbonate, green precipitate.....lb.	—	.50 — .60
Copper cyanide.....lb.	.06 — .06½	.07 — .07½
Copper sulphate, crystals.....lb.	—	—
Cream of tartar (see potassium bitartrate).....lb.	—	—
Epsom salt (see magnesium sulphate).....gal.	—	1.05 — 1.10
Ethyl Acetate Com. 85% to 100%.....gal.	—	—
Ethyl Acetate pure (acetic ether 98% to 100%).....lb.	.18 — .18½	.19 — .19½
Formaldehyde, 40 per cent.....gal.	—	3.50 — 3.60
Fusel oil, ref.....gal.	—	2.75 — 3.00
Fusel oil, crude.....gal.	—	—
Glauber's salt (see sodium sulphate).....lb.	—	.20 — .21
Iodine, C. P. drums extra.....lb.	—	3.85 — 4.00
Iodine, resublimed.....lb.	—	.10 — .20
Iron oxide, red.....100 lb.	1.50 — 1.75	2.00 — 2.25
Iron sulphate (copperas).....lb.	—	.13 — .16
Lead acetate, normal.....lb.	.13 — .14	.14 — .15
Lead arsenate (paste).....lb.	—	.90 — 1.00
Lead nitrate, crystals.....lb.	.10 — .10½	.10 — .11
Litharge.....lb.	—	1.50 —
Lithium carbonate.....lb.	.10 — .11	.11 — .12
Magnesium carbonate, technical.....100 lb.	3.00 — 3.25	—
Magnesium sulphate, U. S. P.....100 lb.	—	1.50 — 1.75
Magnesium sulphate, commercial.....100 lb.	—	1.75 — 1.80
Methanol, 95%.....gal.	—	2.10 — 2.15
Methanol, pure.....gal.	—	.12 — .12½
Nickel salt, double.....lb.	—	.12 — .13
Nickel salt, single.....lb.	—	.13 — .13½
Phosgene (see carbonyl chloride).....lb.	—	—
Phosphorus, red.....lb.	.35 — .37	.38 — .40
Phosphorus, yellow.....lb.	—	.35 — .37
Potassium bichromate.....lb.	.17 — .17½	.18 — .18½

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$ 35 - 40	\$0 38-40 40
Potassium bromide, granular..... lb.	11 - 11	11 - 12
Potassium carbonate, U. S. P..... lb.	12 - 13	13 - 18
Potassium carbonate, crude..... lb.	12 - 13	13 - 18
Potassium chlorate, crystals..... lb.	12 - 13	13 - 18
Potassium cyanide..... lb.	14 - 14	15 - 16
Potassium hydroxide (caustic p. tash)..... lb.	14 - 14	15 - 16
Potassium iodide..... lb.	75 00 - 80 00	3 00 - 3 20
Potassium nitrate..... lb.	11 - 12	12 - 13
Potassium permanganate..... lb.	60 - 63	65 - 70
Potassium prussiate, red..... lb.	55 - 57	58 - 60
Potassium prussiate, yellow..... lb.	32 - 32	33 - 33
Potassium sulphate (powdered)..... ton	\$225 00 - 230 00	
Rochelle salts (see sodium potas- tartrate)		
Sal ammoniac (see ammonium chloride)		
Sal soda (see sodium carbonate)		
Salt cake..... ton		45 00 - 50 00
Silver cyanide..... oz.		1 25 - 1 25
Silver nitrate..... oz.		43 - 45
Soda ash, light..... 100 lb.	1 90 - 2 00	2 10 - 2 30
Soda ash, dense..... 100 lb.	2 30 - 2 50	2 75 - 3 00
Sodium acetate..... lb.	05 - 05	05 - 06
Sodium bicarbonate..... 100 lb.	2 45 - 2 60	2 65 - 3 00
Sodium bichromate..... lb.	09 - 09	09 - 10
Sodium bisulphate (nitre cake)..... ton	7 00 - 7 50	8 00 - 11 00
Sodium bisulphate powdered, U. S. P..... lb.	06 - 07	07 - 08
Sodium borate (borax)..... lb.	07 - 08	08 - 08
Sodium carbonate (sal soda)..... 100 lb.	2 00 - 2 25	2 50 - 2 75
Sodium chl rate..... lb.	10 - 10	10 - 11
Sodium cyanide, 96-98 per cent..... lb.	22 - 24	26 - 29
Sodium fluoride..... lb.	17 - 17	17 - 18
Sodium hydroxide (caustic soda)..... 100 lb.	3 75 - 4 00	4 25 - 4 35
Sodium hyposulphite..... lb.		03 - 04
Sodium nitrate..... 100 lb.	2 85 - 3 00	3 00 - 3 00
Sodium nitrite..... lb.	06 - 06	06 - 07
Sodium peroxide, powdered..... lb.	30 - 31	32 - 34
Sodium phosphate, dibasic..... lb.	03 - 04	04 - 05
Sodium potassium tartrate (Rochelle salt)..... lb.		33 - 35
Sodium prussiate, yellow..... lb.	17 - 17	18 - 18
Sodium silicate, solution (40 deg.)..... lb.	01 - 01	02 - 02
Sodium silicate, solution (60 deg.)..... lb.	03 - 03	03 - 04
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1 75 - 2 00	2 25 - 2 50
Sodium sulphide, crystals, 60-62 per cent (conc.) lb.	06 - 06	07 - 07
Sodium sulphite, crystals..... lb.	04 - 04	04 - 05
Strontium nitrate, powdered..... lb.	20 - 20	21 - 22
Sulphur chl ride, red..... lb.	08 - 09	10 - 10
Sulphur, crude..... ton	16 00 - 20 00	
Sulphur dioxide, liquid, cylinders..... lb.	09 - 09	10 - 12
Sulphur (sublimed), flour..... 100 lb.		3 70 - 4 35
Sulphur, roll (brimstone)..... 100 lb.		3 40 - 3 90
Tin bichloride, 50 per cent..... lb.	18 - 19	
Tin oxide..... lb.		50 - 51
Zinc carbonate, precipitate..... lb.	16 - 18	19 - 20
Zinc chloride, gran..... lb.	12 - 13	13 - 14
Zinc cyanide..... lb.	45 - 49	50 - 60
Zinc dust..... lb.	12 - 13	13 - 14
Zinc oxide, XX..... lb.	10 - 10	11 - 11
Zinc sulphate..... lb.	03 - 03	04 - 06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1 10 - \$1 15
Alpha-naphthol, refined..... lb.	1 45 - 1 50
Alpha-naphthylamine..... lb.	40 - 44
Aniline oil, drums extra..... lb.	22 - 26
Aniline salts..... lb.	27 - 30
Anthracene, 80%, in drums (100 lb.)..... lb.	90 - 1 00
Benzaldehyde (f.f.c.)..... lb.	2 00 - 2 10
Benzidine, base..... lb.	1 00 - 1 10
Benzidine sulphate..... lb.	85 - 90
Benzoic acid, U. S. P..... lb.	70 - 75
Benzoate of soda, U. S. P..... lb.	75 - 85
Benzene, pure, water-white, in drums (100 gal.)..... gal.	32 - 35
Benzene, 90%, in drums (100 gal.)..... gal.	30 - 32
Benzyl chloride, 95-97%, refined..... lb.	35 - 40
Benzyl chloride, tech..... lb.	25 - 35
Beta-naphthol benzoate..... lb.	3 50 - 4 00
Beta-naphthol, sublimed..... lb.	75 - 80
Beta-naphthol, tech (nominal)..... lb.	40 - 45
Beta-naphthylamine, sublimed..... lb.	2 25 - 2 40
Cresol, U. S. P., in drums (100 lb.)..... lb.	16 - 18
Ortho-cresol, in drums (100 lb.)..... lb.	13 - 25
Cresylic acid, 97-99%, straw color, in drums..... gal.	95 - 1 00
Cresylic acid, 75-97%, dark, in drums..... gal.	90 - 95
Cresylic acid, 50%, first quality, drums..... gal.	65 - 75
Dichlorobenzene..... lb.	07 - 15
Diethylaniline..... lb.	1 35 - 1 40
Dimethylaniline..... lb.	65 - 90
Dinitrobenzene..... lb.	30 - 37
Dinitrochlorobenzene..... lb.	25 - 30
Dinitronaphthalene..... lb.	40 - 45
Dinitrophenol..... lb.	40 - 45
Dinitrotoluene..... lb.	30 - 32
Dip oil, 25%, tar acids, car lots, in drums..... gal.	38 - 40
Diphenylamine..... lb.	70 - 75
H-acid..... lb.	1 40 - 1 55
Meta-phenylenediamine..... lb.	1 25 - 1 30
Monochlorobenzene..... lb.	15 - 16
Monoethylaniline..... lb.	1 75 - 2 25
Naphthalene crushed, in bbls. (250 lb.)..... lb.	08 - 08
Naphthalene, flake..... lb.	08 - 08
Naphthalene, balls..... lb.	09 - 09
Naphthalonic acid, crude..... lb.	70 - 75
Nitrobenzene..... lb.	12 - 15
Nitro-naphthalene..... lb.	40 - 50
Nitro-toluene..... lb.	18 - 25
Ortho-amidophenol..... lb.	3 20 - 3 75
Ortho-dichlorobenzene..... lb.	15 - 20
Ortho-nitro-phenol..... lb.	75 - 80
Ortho-nitro-toluene..... lb.	25 - 30
Ortho-toluidine..... lb.	25 - 30
Para-amidophenol, base..... lb.	2 20 - 2 25
Para-amidophenol, HCl..... lb.	2 10 - 2 15

Para-dichlorobenzene..... lb.	10 - 15
Paranitroaniline..... lb.	93 - 1 00
Para-nitrotoluene..... lb.	1 25 - 1 40
Para-phenylenediamine..... lb.	2 20 - 2 35
Para-toluidine..... lb.	1 70 - 1 80
Phthalic anhydride..... lb.	60 - 70
Phenol, U. S. P., drums (dest.), (240 lb.)..... lb.	09 - 10
Pyridine..... gal.	2 00 - 3 50
Resorcinol, technical..... lb.	2 75 - 2 80
Resorcinol, pure..... lb.	3 60 - 3 80
Salicylic acid, tech., in bbls. (110 lb.)..... lb.	32 - 33
Salicylic acid, U. S. P..... lb.	35 - 37
Salol..... lb.	85 - 95
Solvent naphtha, water-white, in drums, 100 gal..... gal.	30 - 35
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	19 - 22
Sulphanilic acid, crude..... lb.	32 - 35
Tolidine..... lb.	1 35 - 1 40
Toluidine, mixed..... lb.	45 - 55
Toluene, in tank cars..... gal.	30 - 32
Toluene, in drums..... gal.	33 - 35
Xylidines, drums, 100 gal..... lb.	45 - 50
Xylene, pure, in drums..... gal.	42 - 45
Xylene, pure, in tank cars..... gal.	45 - 48
Xylene, commercial, in drums, 100 gal..... gal.	37 - 38
Xylene, commercial, in tank cars..... gal.	30 - 35

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$3 26 - \$0 27
Beeswax, refined, light..... lb.	28 - 30
Beeswax, white pure..... lb.	35 - 40
Carnauba, No. 1..... lb.	85 - 90
Carnauba, No. 2, North Country..... lb.	45 - 50
Carnauba, No. 3, North Country..... lb.	20 - 25
Japan..... lb.	19 - 20
Montan, crude..... lb.	07 - 08
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	06 - 06
Paraffine waxes, crude, scale 124-126 m.p..... lb.	06 - 06
Paraffine waxes, refined, 118-120 m.p..... lb.	07 - 07
Paraffine waxes, refined, 125 m.p..... lb.	07 - 08
Paraffine waxes, refined, 128-130 m.p..... lb.	08 - 09
Paraffine waxes, refined, 133-135 m.p..... lb.	10 - 11
Paraffine waxes, refined, 135-137 m.p..... lb.	11 - 12
Stearic acid, single pressed..... lb.	14 - 15
Stearic acid, double pressed..... lb.	15 - 15
Stearic acid, triple pressed..... lb.	16 - 16

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1 90
Pine oil, pure, dest. dist..... gal.	1 50
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	35
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	75
Pine tar, ref., thin, sp.gr. 1.080-1.060..... gal.	36
Turpentine, crude, sp.gr. 0.900-0.970..... gal.	1 25
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990..... gal.	35
Pine wood creosote, ref..... gal.	52

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B..... bbl.	280 lb.	\$8 75 -
Rosin E-I..... bbl.	280 lb.	8 75 -
Rosin K-N..... bbl.	280 lb.	8 75 -
Rosin W. G.-W. W..... bbl.	280 lb.	9 00 -
Wood rosin, bbl..... bbl.	280 lb.	9 00 -
Spirits of turpentine..... gal.		76 -
Wood turpentine, steam dist..... gal.		74 -
Wood turpentine, dest. dist..... gal.		74 -
Pine tar pitch, bbl..... 200 lb.		8 50
Tar, kila burned, bbl. (500 lb.)..... bbl.		15 00
Retort tar, bbl..... 500 lb.		15 00
Rosin oil, first run..... gal.		60 -
Rosin oil, second run..... gal.		62 -
Rosin oil, third run..... gal.		75 -

Solvents

73-75 deg., steel bbls. (85 lb.)..... gal.	\$0 41
70-72 deg., steel bbls. (85 lb.)..... gal.	39
68-70 deg., steel bbls. (85 lb.)..... gal.	38
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	30

Crude Rubber

Para-Upriver fine..... lb.	\$0 18 - \$0 19
Upriver coarse..... lb.	14 - 14
Upriver cauchoo ball..... lb.	14 - 14
Plantation—First latex crepe..... lb.	17 -
Ribbed smoked sheets..... lb.	16 -
Brown crepe, thin, clean..... lb.	16 -
Amber crepe No. 1..... lb.	17 -

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0 10 - \$0 11
Castor oil, A.A., in bbls..... lb.	12 - 13
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	09 - 09
Cocanut oil, Ceylon grade, in bbls..... lb.	13 - 13
Cocanut oil, Cochon grade, in bbls..... lb.	13 - 14
Cor i oil, crude, in bbls..... lb.	09 - 09
Cottonseed oil, crude (f. o. b. mill)..... lb.	06 - 07
Cottonseed oil, summer yellow..... lb.	08 - 08
Cottonseed oil, winter yellow..... lb.	09 - 09
Linseed oil, raw, car lots (domestic)..... gal.	77 - 79
Linseed oil, raw, tank cars (domestic)..... gal.	73 - 74
Linseed oil, boiled, car lots (domestic)..... gal.	78 - 80

Olive oil, commercial.....	gal.	2.60	—	2.70
Palm, Lagos.....	lb.	.07	—	.08
Palm, Niger.....	lb.	.07	—	.08
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.07	—	.07
Peanut oil, refined, in bbls.....	lb.	.13	—	.13
Rapeseed oil, refined in bbls.....	gal.	1.10	—	1.15
Rapeseed oil, blown, in bbls.....	gal.	1.20	—	1.25
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.08	—	.09
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.06	—	.07

FISH

Light pressed Menhaden.....	gal.	\$0.53	—	\$0.55
Yellow bleached Menhaden.....	gal.	.55	—	.58
White bleached Menhaden.....	gal.	.57	—	.60
Blown Menhaden.....	gal.	1.00	—	....

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	\$24.00	—	\$30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri	net ton	10.00	—	....
Blanc fixe, dry.....	lb.	.05	—	.05
Blanc fixe, pulp.....	net ton	60.00	—	65.00
Caeine.....	lb.	.14	—	.18
Chalk, domestic, extra light.....	lb.	.05	—	.06
Chalk, domestic, light.....	lb.	.04	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04	—	.05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	8.00	—	10.00
China clay (Kaolin) washed, f.o.b. Georgia	net ton	12.00	—	15.00
China clay (Kaolin) powdered, f.o.b. Georgia	net ton	18.00	—	22.00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8.00	—	12.00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15.00	—	40.00
China clay (Kaolin), imported, lump.....	net ton	25.00	—	35.00
China clay (Kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fuller's Earth, f.o.b. New York.....	net ton	16.00	—	17.00
Fuller's earth, granular, f.o.b. Fla.....	net ton	25.00	—	....
Fuller's earth, powdered, f.o.b. Fla.....	net ton	18.00	—	....
Fuller's earth, imported, powdered.....	net ton	35.00	—	40.00
Graphite, crucible, 90% carbon, Ashland, Ala.....	lb.	....	—	.09
Graphite, crucible, 85% carbon, Ashland, Ala.....	lb.	.07	—	.09
Graphite, higher lubricating grades.....	lb.	.11	—	.40
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic, lump.....	lb.	.06	—	....
Pumice stone, ground.....	lb.	.04	—	.07
Quartz (acid tower) flat to head, f.o.b. Baltimore	net ton	....	—	10.00
Quartz (acid tower) 1 1/2 @ 2 in., f.o.b. Baltimore	net ton	....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	1.00	—	1.05
Shellac, orange superfine.....	lb.	1.05	—	1.10
Shellac, A. C. garnet.....	lb.	.90	—	.95
Shellac, T. N.....	lb.	.85	—	.95
Sonapstone.....	ton	15.00	—	25.00
Sodium Chloride.....	long ton	....	—	17.50
Talc, paper-making grades, f.o.b. Vermont.....	ton	12.00	—	22.00
Talc, roofing grades, f.o.b. Vermont.....	ton	9.50	—	15.00
Talc, rubber grades, f.o.b. Vermont.....	ton	12.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	12.00	—	15.00
Talc, imported.....	ton	60.00	—	70.00
Tals, California Talcum Powder grade.....	ton	20.00	—	45.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160	—	....
Chrome brick, f.o.b. Eastern shipping points.....	net ton	100-110	—	....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	55-60	—	....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	60-65	—	....
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55-60	—	....
Fire clay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45-50	—	....
Magnesite brick, 9-in. straight.....	net ton	110	—	....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	121	—	....
Magnesite brick, soaps and splits.....	net ton	134	—	....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	65-70	—	....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	56-61	—	....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	55-60	—	....

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.16	—	.17
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.17	—	.18
Ferro-manganese, 76-80% Mn, domestic.....	gross ton	120.00	—	125.00
Ferro-manganese, 76-80% Mn, English.....	gross ton	130.00	—	135.00
Spiegelisen, 18-22% Mn.....	gross ton	60.00	—	65.00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.00	—	2.50
Ferro-silicon, 10-15%.....	gross ton	55.00	—	60.00
Ferro-silicon, 50%.....	gross ton	78.00	—	80.00
Ferro-silicon, 75%.....	gross ton	....	—	150.00
Ferro-tungsten, 70-80%, per lb. of contained W.....	lb.	.55	—	.60
Ferro-uranium, 35-50% of U, per lb. of U content lb.....	7.00	....	—	....
Ferro-vanadium, 30-40% per lb. of contained V.....	lb.	6.50	—	7.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al. content, less than 2% Fe ₂ O ₃ , up to 20% silica, not more than H ₂ O moisture.....	gross ton	\$10.00	—	\$11.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.60	—	.65
Chrome ore, 50%, Cr ₂ O ₃ , f.o.b. Atlantic Seaboard.....	unit	.55	—	.60
Coke, foundry, f.o.b. ovens.....	net ton	....	—	7.00
Coke, furnace, f.o.b. ovens.....	net ton	....	—	6.00
Coke, petroleum, refinery, Atlantic Seaboard.....	net ton	21.00	—	22.00
Fluor spar, lump, f.o.b. Tonuco, New Mexico.....	net ton	17.50	—	....
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	22.50	—	25.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01	—	.01
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport	unit	.40	—	.45
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y. lb.....	lb.	.55	—	.60
Monasite, per unit of ThO ₂ , c.i.f. Atlantic seaport	unit	35.00	—	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.12	—	....
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport.....	unit	.17	—	....
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.14
Rutile, 95% TiO ₂ , per lb. ore.....	lb.	.15	—	....
Tungsten, Scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.75	—	4.00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	4.00	—	4.25
Uranium Ore (Carnotite) per lb. of U ₃ O ₈	lb.	2.75	—	3.00
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.75	—	3.00
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium Ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	—	....
Zircon, washed, iron free.....	lb.	.05	—	....

Non-Ferrous Metals

New York Markets

	Cents per lb.
Copper, electrolytic.....	15 00
Aluminum, 98 to 99 per cent.....	27 50
Antimony, wholesale lots, Chinese and Japanese.....	5.25 @ 5.37
Nickel, ordinary (ingot).....	43 00
Nickel, electrolytic.....	45 00
Tin, 5-ton lots.....	34 02
Lead, New York, spot.....	5 37
Lead, E. St. Louis, spot.....	6 25
Zinc, spot, New York.....	7 00
Zinc, spot, E. St. Louis.....	6 75

OTHER METALS

Silver (commercial).....	os.	\$0 65
Cadmium.....	lb.	1.40 @ 1.50
Bismuth (500 lb. lots).....	lb.	2.40
Cobalt.....	lb.	6.00
Magnesium (f.o.b. Philadelphia).....	lb.	1.35
Platinum.....	os.	75 00
Iridium.....	os.	350.00 @ 400.00
Palladium.....	os.	75 00
Mercury.....	75 lb.	50 00

FINISHED METAL PRODUCTS

Warehouse Price
Cents per lb.

Copper sheets, hot rolled.....	22 50
Copper bottoms.....	34 00
Copper rods.....	29 00
High brass wire and sheets.....	20 25
High brass rods.....	18 25
Low brass wire and sheets.....	30 50
Low brass rods.....	19 50
Brass tubing.....	36 25
Brass, heavy.....	41 50
Seamless copper tubing.....	26 00
Seamless high brass tubing.....	25 00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York				Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Copper, heavy and crucible.....	12 00	17 00	10 00	11 50	....	....	....	....
Copper, heavy and wire.....	11 50	16 00	9 50	11 00	....	....	....	....
Copper, light and bottoms.....	10 00	14 00	9 00	9 50	....	....	....	....
Lead, heavy.....	4 00	4 75	4 00	4 50	....	....	....	....
Lead, tea.....	3 00	3 75	3 00	3 50	....	....	....	....
Brass, heavy.....	7 00	10 50	7 00	10 50	....	....	....	....
Brass, light.....	5 50	7 50	5 00	5 50	....	....	....	....
No. 1 yellow brass turnings.....	6 50	10 00	5 50	5 50	....	....	....	....
Zinc.....	4 50	5 00	3 00	4 50	....	....	....	....

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes.....	\$3.80	\$4.15	\$3.47	\$3.58	\$3.58	\$3.47
Soft steel bars.....	3.70	4.15	3.37	3.34	3.48	3.37
Soft steel bar shapes.....	3.70	4.15	3.37	3.48	3.48	3.37
Soft steel bands.....	4.65	5.50	4.07	6.25	....	....
Plates, 1/2 to 1 in. thick.....	4.00	4.15	3.67	3.78	3.78	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

EL CENTRO—The City Council plans an election in January to vote on \$125,000 to purchase and enlarge the present privately owned gas plant. W. F. Holt, principal owner.

LOS ANGELES—The Consolidated Vanadium Co., 1225 Washington Bldg., has awarded the contract for the construction of a 1-story, 50x50-ft. factory for the manufacture of vanadium products, to the Union Iron Works, 5125 Santa Fe Ave., Estimated cost, \$4,000.

Massachusetts

WAKEFIELD—The town plans to install equipment in the gas plant of the municipal light plant. Estimated cost, \$250,000.

Colorado

LA JUNTA—The town plans an election Jan. 20 to vote on \$200,000 bonds to construct a high school. A chemical laboratory will be installed in same.

Georgia

CREST—The Taylor Graphite Co. plans to install mining and concentrating equipment. Estimated cost, \$23,000. J. E. Taylor, pres.

Iowa

CHARLES CITY—The city is having plans prepared for the construction of a sewage disposal plant. Estimated cost, \$25,000. W. E. Buell, 228 Davidson Bldg., Sioux City, engr.

DECORAH—The Bd. Educ. plans an election Jan. 10 to vote on \$150,000 bonds to construct a 2- or 3-story high school. A chemical laboratory will be installed in same. C. F. Barefoot, secy.

KEOKUK—The city plans an election soon to vote on \$500,000 bonds to build a 3-story high school. A chemical laboratory will be installed in same. F. C. Smith, secy.

Maryland

BALTIMORE—The School Bd. of Awards has awarded the contract for the construction of a 3-story, 76x271-ft. school on Latrobe Park and Fort Ave., to the Standard Constr. Co., 1713 Sansom St., Philadelphia, Pa. A chemical laboratory will be installed in same.

Minnesota

NEW PRAGUE—J. E. Bruzek, city clk., will soon receive bids for the construction of a sewage disposal plant. Estimated cost, \$50,000. J. W. Shaffer & Co., 917 New York Life Bldg., Minneapolis, engr.

NORTHFIELD—St. Olaf's College plans to build a 3-story, 73x186-ft. science hall. A chemical laboratory will be installed in same. Estimated cost, \$500,000. N. E. Mohn, 596 Endicott Bldg., St. Paul, archt.

RENVILLE—A. R. Holmberg, clk. of the Bd. Educ. will receive bids until Jan. 18 for the construction of a 2-story, 146x273-ft. grade and high school. Estimated cost, \$280,000. Croft & Boerner, 1006 Marquette Ave., Minneapolis, archts.

Montana

MILES CITY—The Bd. Educ., c/o Olive Lovett, Supt. of Schools, has had plans prepared for the construction of a 3-story high school. A chemical laboratory will be installed in same. Estimated cost, \$400,000.

New Jersey

NEWARK—The Butterworth-Judson Corp., Doremus Ave., has had plans prepared for the reconstruction of a 3-story paranitraniline unit of its plant which was recently destroyed by fire. Estimated cost, \$180,000.

North Dakota

BISMARCK—The city will soon award the contract for the construction of a waterworks system to include reservoirs, filtration plant, pumping station, distributing system, etc. Estimated cost, \$1,300,000. L. R. Wolff, 1000 Guardian Life Bldg., St. Paul, Minn., engr. Noted June 30.

Ohio

HOLGATE—The town will receive bids until Jan. 8 for altering and building a 2-story, 66x155-ft. addition to the high school. Chemical equipment will be installed in same. Estimated cost, \$90,000. O. L. C. Zachsich, clk. S. P. Stewart & Son, Bowling Green, archts.

Oklahoma

VINITA—The city has had plans prepared for the construction of a purification plant to include liquid chlorine treatment and sand filters, etc. Estimated cost, \$460,000. H. G. Olmsted & Co., 417 Oil Exch., Oklahoma City, engr. Noted Nov. 24.

South Dakota

MCINTOSH—The Bd. Educ. will receive bids until Jan. 24 for the construction of a 2-story grade and high school. A chemical laboratory will be installed in same. Estimated cost, \$150,000. E. J. Geers, clk. G. Issenhuith, Huron, archt.

Virginia

NORFOLK—The Western Junior High School plans to build a 4-story, 150x310-ft. high school. A chemical laboratory will be installed in same. Estimated cost, \$700,000.

Wisconsin

DURAND—The Bd. Educ., c/o H. A. Miles, secy., is having plans prepared for the construction of a 2-story, 80x124-ft. high school. A chemical laboratory will be installed in same. Estimated cost, \$100,000. Oppenheimer & Obel, Wausau, archts. Noted Aug. 25.

FOND DU LAC—The Bd. Educ., c/o A. M. Hunter, secy., has had plans prepared for the construction of a 3-story, 110x115-ft. senior high school on Linden St. A chemical laboratory will be installed in same. Estimated cost, \$275,000. Childs & Smith, 64 East Van Buren St., Chicago, archts.

HARTFORD—The city retained J. Donohue, engr., 720 New York Ave., Sheboygan, to prepare plans for altering the sewerage system, building septic tank, etc. Estimated cost, \$50,000. W. Radke, city clk.

KIMBERLY—The city engaged F. A. C. Smith, engr., Colby-Abbott Bldg., Milwaukee, to prepare plans for the construction of a sewerage system and sewage disposal plant. Estimated cost, \$100,000.

MILWAUKEE—T. Rogers, chemist, c/o Dept. of Pub. Wks., plans to install \$15,000 worth of special equipment in the garbage plant for the purpose of determining the practicability of making alcohol from garbage.

OCONTO FALLS—The Bd. Educ., c/o G. Krohn, secy., is having plans prepared for the construction of a 1-story, 76x100-ft. high and grade school on Main St. A chemical laboratory will be installed in same. Estimated cost, \$100,000. Juul & Smith, Imig Bldg., Sheboygan, archts.

WEST ALLIS—The City Council plans to build an addition to the septic tank. Estimated cost, between \$15,000 and \$25,000. A. Schneider, City Hall, engr.

Ontario

SMITHS FALLS—The town plans to construct a filtration plant. Estimated cost, \$15,000. J. A. Lewis, clk.

Quebec

MONTREAL—The Can. Welding Co., Amherst St. near Ontario St., plans to construct a plant, including equipment. Estimated cost, \$60,000.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its annual meeting Feb. 21 to 24, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29, 1921.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting Feb. 14 to 17 in New York City.

COMMON BRICK MANUFACTURERS' ASSOCIATION OF AMERICA will hold its annual meeting at the Hotel Pennsylvania, New York City, Jan. 31 to Feb. 4.

COMPRESSED GAS MANUFACTURERS' ASSOCIATION will hold its eighth annual meeting, Monday, Jan. 17, 1921, at 2 p.m., at the Hotel Astor, New York, and its eighth annual dinner at the same place that evening.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetter's Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF CHEMICAL INDUSTRY holds its Perkin Medal Award Meeting at Rumford Hall, Chemists' Club, New York, on Jan. 14, 1921.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Jan. 7, American Chemical Society; Jan. 14, Society of Chemical Industry, Perkin Medal award; Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society, Nichols Medal award; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

Industrial Notes

THE JAPANESE TISSUE MILLS, INC., of Holyoke, Mass., which is a combination of the former Mt. Holyoke Tissue and Japanese Tissue Mills, has changed its name to the American Tissue Mills. Important changes are being made in the company.

THE AMHERST WAXED PAPER CO., Amherst, Mass., is preparing to locate in Holyoke, Mass., in a building constructed some time ago by J. L. Perkins, who purchased the company some years back. The new mill is being fitted up with waxed paper machinery and will employ 100 hands when operating to full capacity. The present mill is located at Amherst and will be retained for some time to come.

THE CIVIC AND COMMERCIAL ASSOCIATION of Denver, Col., is making a research study for the porcelain industry for the benefit of the city; Homer B. Vanderblui, of the industrial research department, is spending three weeks in the ceramic industries, particularly at Liverpool, O. He will make arrangements for the testing of Colorado clays by the experts of the Ohio region and investigation as to the various possible uses in the manufacture of porcelain. Technical investigations will later be made in co-operation with the Colorado Society of Engineers, which has offered to participate in the work.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO., East Pittsburgh, Pa., has initiated a part-time employment plan, in order that engineering students of the University of Pittsburgh and the Carnegie Institute of Technology may be able to gain practical knowledge regarding the production and testing of electrical apparatus, and at the same time earn extra money. Students are allowed the regular hourly rate for work on Saturday afternoons, Sunday and holidays. For the most part the employment consists of store-keeping, which allows the students to become familiar with the size and character of the different kinds of electrical apparatus.

THE STAR BRASS WORKS, 3114-28 Carroll Ave., Chicago, announces that on and after Jan. 1, 1921, the company name will be changed to Binks Spray Equipment Co. Such change of name has been made to conform more nearly with the nature of the products manufactured. Simultaneously announcement is also made of the completion of a new plant and office extension on the west wing of the old plant in which provisions are made for new salesroom, testing laboratories, and greatly increased manufacturing facilities on the first floor, with new offices and drafting rooms on the second floor. This company also announces the establishment of a Pacific Coast office in charge of L. M. Page, Rialto Bldg., San Francisco.

THE MAX-LEW CHEMICAL CO., of 20 Clinton St., Newark, N. J., with David E. Bernstein as agent, has been chartered in the office of the Secretary of State to operate in New Jersey in the manufacture and sale of chemicals, alkalis, etc., as some of its principal objects. The concern has a capitalization of \$100,000, which is divided into 1,000 shares at \$100 each, while the amount that will be devoted to the starting of business is \$3,000. The incorporators and the number of shares held by each are Max Lewitt, of 68 Howard St., Newark, N. J., 10; George Lewitt, of 68 Howard St., Newark, N. Y., 10; and Abraham Lewitt, of 68 Howard St., Newark, N. J., 10.

THE METAL & THERMIT CORP., New York, announces that O. E. Falls, who has had many years of experience in charge of foundry and thermit welding work at the Norfolk Navy Yard, Portsmouth, Va., has accepted a position with it. Announcement is also made of the opening of a branch office at 141 Milk St., Boston, in charge of Robert L. Browne.

THE ELECTRIC FURNACE CO., Alliance, O., has just shipped 20 165-kw. Baily units to Norway, where they will be used to melt zinc at the Jossingfjord plant in Stavanger, and to melt aluminum at the Norsk Aluminium Works at Christiania. Complete rolling mill brass-melting furnaces, designed for pouring the metal directly into the molds, have recently been shipped by this company to the Amsinck Corp. of Mexico, Mitsui & Co. of Japan, and Allen Everett, Ltd., of England. In addition to these units Baily electric furnaces have recently been installed at three Canadian plants: The Dominion Steel Products Co. of Brantford, Ont., the Monarch Metals Co. of Hamilton, Ont., and the Union Screen Plate Co. of Lennoxville, Que.

New Publications

NEW BUREAU OF STANDARDS PUBLICATIONS: Sci. Paper 392, A Photographic Method of Detecting Changes in a Complicated Group of Objects, by M. H. Stillman; Sci. Paper 394, Air Forces on Circular Cylinders, Axes Normal to the Wind, With Special Reference to Dynamical Similarity, by Hugh L. Dryden; Sci. Paper 395, Relation of the High-Temperature Treatment of High-Speed Steel to Secondary Hardening and Red-Hardness, by Howard Scott; Sci. Paper 397, A Study of the Relation Between the Brinell Hardness and the Grain Size of Annealed Carbon Steels, by Henry S. Rawdon and Emilio Jimeno-Gill; Sci. Paper 400, Ionization and Resonance Potentials of Some Non-Metall'c Elements, by F. L. Mohler and Paul D. Foote; Tech. Paper 167, An Examination of the Munsell Color System, by Irwin G. Priest, K. S. Gibson and H. J. McNicholas; Tech. Paper 172, Cast Iron for Locomotive-Cylinder Parts, by C. H. Strand; Tech. Paper 174, Effects of Cal as an Accelerator of the Hardening of Portland Cement Mixtures, by Roy N. Young; Tech. Paper 175, Pouring and Pressure Tests of Concrete, by W. A. Slater and A. T. Goldbeck; Tech. Paper 176, Slushing Oils, by Percy H. Walker and Lawrence L. Steele; Tech. Paper 176, Sulphur in Petroleum Oils, by C. E. Waters.

NEW BUREAU OF FOREIGN AND DOMESTIC COMMERCE PUBLICATIONS: Schedule Governing the Statistical Classification of Imports Into the United States, with rates of duty and regulations governing the preparation of monthly and quarterly statements of imports; Statistical Classification of Domestic Commodities Exported From the U. S.

NEW U. S. GEOLOGICAL SURVEY PUBLICATIONS: Natural-Gas Gasoline in 1918, by E. G. Sievers (Mineral Resources of the U. S., 1918, Part II), published Sept. 22, 1920; I: 2, Platinum and Allied Metals in 1918, by James M. Hill (Mineral Resources of the U. S., 1918, Part I), published July 30, 1920; I: 3, Arsenic, Bismuth, Selenium and Tellurium in 1919, by James M. Hill (Mineral Resources of the U. S., 1919,

Part I), published Sept. 16, 1920; I: 5, Bauxite and Aluminum in 1919, by James M. Hill (Mineral Resources of the U. S., 1919, Part I), published Aug. 30, 1920; I: 6, Gold, Silver, Copper, Lead and Zinc in the Eastern States in 1919, by J. P. Dunlop (Mineral Resources of the United States, 1919, Part I), published Nov. 8, 1920; I: 24, Gold and Silver in 1919 (General Report), by J. P. Dunlop (Mineral Resources of the United States, 1918, Part I), published July 15, 1920; I: 25, Nickel in 1918, by Frank L. Hess (Mineral Resources of the U. S., 1918, Part I), published June 29, 1920; II: 4, Peat in 1919, by K. W. Cottrell (Mineral Resources of the U. S., 1919, Part II), published Oct. 14, 1920; I: 26, Cobalt Molybdenum, Tantalum, Titanium, Radium, Uranium and Vanadium in 1918, by Frank L. Hess (Mineral Resources of the U. S., 1918, Part I), published June 29, 1920; I: 28, Copper in 1918, by B. S. Butler (Mineral Resources of the U. S., 1918, Part I), published Sept. 28, 1920; I: 29, Cobalt, Molybdenum, Nickel, Titanium, Tungsten, Radium, Uranium and Vanadium in 1917, by Frank L. Hess (Mineral Resources of the U. S., 1917, Part I), published Aug. 31, 1920; II: 1, Thorium, Zirconium and Rare-Earth Minerals in 1919, by Waldemar T. Schaller (Mineral Resources of the U. S., 1919, Part II), published Sept. 1, 1920; II: 2, Fuel Briquetting in 1919, by F. G. Tyrone (Mineral Resources of the U. S., 1919, Part II), published Aug. 13, 1920; II: 28, Lime in 1918, by G. F. Loughlin and Herbert Insley (Mineral Resources of the U. S., 1918, Part II), published June 7, 1920; II: 29, Clay-Working Industries, Silica Brick and Building Operations in the Larger Cities in 1918, by Jefferson Middleton (Mineral Resources of the U. S., 1918, Part II), published July 14, 1920; II: 33, Abrasive Materials in 1918, by Frank J. Katz (Mineral Resources of the U. S., 1918, Part II), published Aug. 27, 1920; II: 34, Stone in 1918, by G. F. Loughlin and A. T. Coons (Mineral Resources of the U. S., 1918, Part II), published Oct. 11, 1920.

Manufacturers' Catalogs

AMERICAN TERRA COTTA CO., Chicago, Ill., is now publishing a house organ entitled *Common Clay*, which deserves special mention as to reading matter and illustrations. W. D. Gates, president of the company and dean of Chicago ceramists, writes a department called "Button-hole Talks." These talks are bits of philosophy well worth reading. The American Terra Cotta Co. manufactures art and ornamental terra cotta and the publication is a successful exposition of the company's artistic developments.

CLARENCE W. MARSH, 101 Park Ave., New York City, has published an instructive folder on the Marsh electrolytic cell for chlorine and caustic soda.

W. S. ROCKWELL CO., New York, calls attention to Bull. 222. In this bulletin the purpose is not to talk about furnaces of the company's manufacture, but to place before the furnace-using public the principles drawn from the company's experience, prints of actual installations being used to illustrate the points raised. Such points include: The applicability of car-type and car-and-ball type furnaces to the heat-treatment of material that cannot be advantageously handled in other types of furnaces; factors governing selection of the type (car or car-and-ball) best suited to individual manufacturing requirements; the difference in design of each type; influence of unequal cooling on the quality of finished product; typical heat-treatment installations involving the use of car-type and car-and-ball type furnaces.

THE METAL & THERMIT CORP., New York, has just issued and will distribute on request the third edition of the Thermit Welding pamphlet No. 17 for mill and foundry repairs. The new edition has been revised and brought up to date both as regards new practices recommended and illustrations showing recent interesting repairs on certain types of equipment since the publication of the former edition. The pamphlet begins with a general discussion of the proper applications and fields for oxy-acetylene, electric and thermit welding, respectively. It then describes in detail the methods to be followed and apparatus used in welding iron and steel sections in general. Later it outlines thoroughly special applications of thermit welding, such as for crankshaft, pinion and roll repairs and also for cast-iron welding. Not previously included in former editions of this pamphlet is a description of a new method of welding teeth in pinions. The pamphlet

concludes by explaining the various applications of thermit in foundry practice, such as for increasing the temperature of iron and steel, facilitating the introduction of other metals which it is desired to alloy for special purposes, making semi-steel in the ladle, keeping metal and risers liquid for a considerable period and making small steel castings. This company also announces a revised Thermit Rail Welding pamphlet, No. 39, which describes the various ways in which thermit welding can be advantageously used for rail welding, and pamphlet No. 20 on thermit carbon-free metals and alloys. The pamphlet, in addition to containing a detailed description of the properties and characteristics of the various carbon-free metals and alloys manufactured by this company, includes an explanation of the advantages of using Tungstabs, or tablets of pure tungsten metal, in the production of high-speed steel and other alloys containing tungsten instead of using tungsten powder and ferrotungsten. Metallurgical losses caused by oxidation in melting and by the absorption of tungsten by the crucible and electric-furnace lining, particularly in the initial heats, are reduced because by using Tungstabs the melting time is decreased and there is a higher recovery of the tungsten owing to the fact that the Tungstabs melt down with the charge.

THE JOSEPH T. RYERSON & SONS CO., Chicago, has issued a leaflet entitled "Do You Know How to Make a Chisel?" which contains a complete description of working, grinding, hardening and tempering the ordinary hand chisel, and will be found of interest to anyone who has to do with the use of chisels generally.

THE BOOTH ELECTRIC FURNACE CO., Chicago, has issued a handsomely illustrated catalog describing the Booth rotating furnaces, giving a list of plants where these are installed. Tables of dimensions of the several sizes appended to blueprints give an accurate idea of the details of construction.

THE MANUFACTURERS' EQUIPMENT CO., Dayton, O., has issued a new bulletin entitled "The Underwood Producer Gas System," which contains descriptions of apparatus and application for burning all kinds of clay products, for glass house furnaces, steel furnaces, the making of carbon products, the heating of enameling furnaces, and the heating of furnaces in chemical and acid plants. The pamphlet contains technical data interesting to those engaged in the above industries.

THE CLEVELAND BREATHING MACHINE CO., Cleveland, O., has issued a 4-page folder on "The Lyon Breathing Machine."

THE CUTLER-HAMMER MFG. CO., Milwaukee, Wis., announces that in order to include information under one cover on C-H products for mine applications a new 48-page illustrated booklet has been prepared, which is entitled "For the Mine." Attention is also called to Publication 867, entitled "Dictionary of Uses" of C-H Electric Space Heaters.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO., East Pittsburgh, Pa., has just received from the Press Bull. 7-A-C-1 on "Mine Locomotive Headlights."

OXWELD ACETYLENE CO., Chicago, Ill., is issuing its new "Ever-ready" instruction book, which is a treatise on every-day oxy-acetylene welding and cutting. This volume, which is 5x8 in., contains fifty-five printed pages, inclusive of illustrations and drawings.

PLANT ENGINEERING & EQUIPMENT CO., New York City, calls attention to a new catalog on Peeco Equipment, which gives illustrations and descriptions of its steam trap gages, valve steam traps, turbo-blowers for steam boilers, Mason condensation meter, etc.

DODGE SALES & ENGINEERING CO., Mishawaka, Ind., has issued Catalog D-20-C on Standardized Elevators and Conveyors, continuous mechanical handling, which is very complete and gives illustrations as well as descriptions.

THE BROWN HOISTING MACHINERY CO., Cleveland, O., has published Catalog K 1921, on Locomotive Cranes. This attractive 88-page catalog illustrates and describes the many types of cranes and equipment.

BLAKE PUMP & CONDENSER CO., Fitchburg, Mass., desires to announce Catalog H-40, on "High-Efficiency Pumping Machinery." The predominating feature of the pumping apparatus shown in this catalog is the application of the Blake-Fitchburg high-efficiency four-bearing type power end to certain types of fluid ends which have been developed to a high efficiency for the particular service to which they are applicable. Many interesting illustrations are given of the different types.